The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D.

July 1942

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PHILIP SYNG PHYSICK (1768-1837). Although occasional reference to absorbable sutures is found in early surgical literature, this famous Philadelphian was responsible for their actual development. In the disintegration of leather when exposed to tissue fluids, he saw the possibility of eliminating wound complications caused by the prolonged presence of non-absorbable ligatures. Buckskin, parchment and kid were tried with encouraging results but catgut was found to be the most satisfactory.

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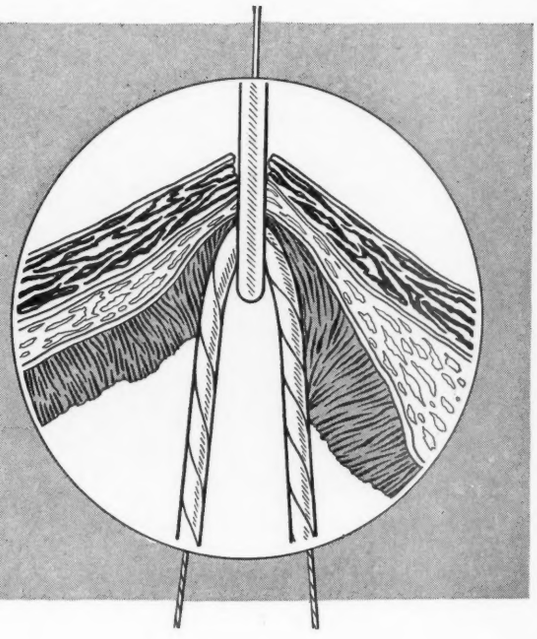

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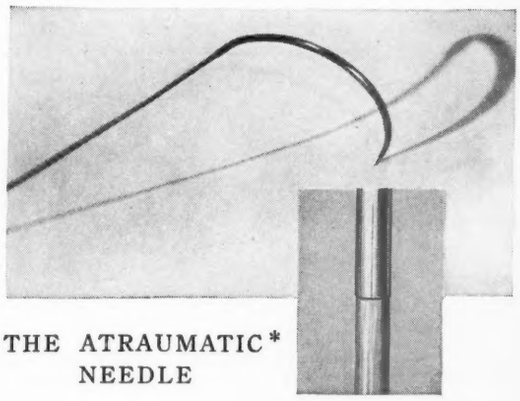

THE ATRAUMATIC* NEEDLE

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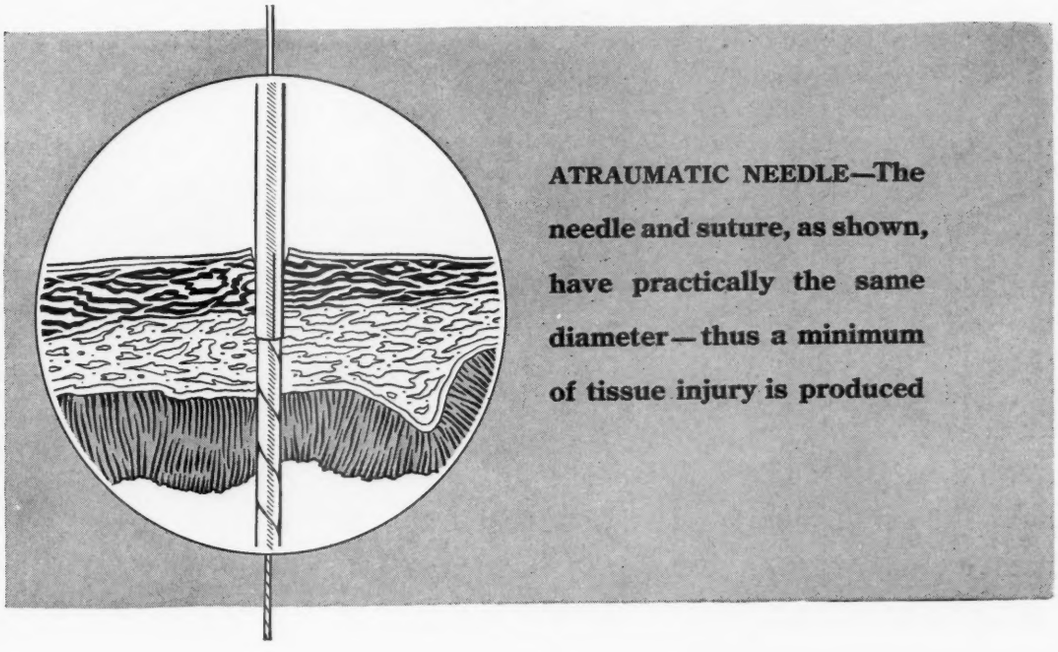

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War Wounds and Sutures

The indications and fundamental principles governing the use of sutures in war wounds are identical with those applying in peacetime traumatic surgery.

The wound must be sutured within the safe period—before bacteria begins to invade the tissues. The debridement must remove all contused tissue and foreign bodies. The sutures should be of fine size and used sparingly. Adequate rest and elevation of the injured part must be provided.

Unfortunately, these conditions cannot always be met in warfare. Considerable time may elapse before treatment can be given. Often crushing and contusion of surrounding tissue is so extensive, especially in bombing casualties, that complete debridement is not feasible. Many war wounds are too large to suture.

Bacterial contamination of the wound may be overwhelming. The soil in combat areas is often heavily laden with bacteria of fecal origin and this type of contamination combined with extensive contusion results in a high incidence of gas gangrene. Shock and massive hemorrhage are frequently encountered and the blood supply of the wounded part may be seriously impaired. The problem of providing adequate rest is complicated by the necessity for evacuating casualties from combat areas.

It becomes apparent, then, that in war surgery the fundamental principles for suturing must, if anything, be adhered to more rigidly than in civil practice.

When sutures are employed, fine-sized catgut is the material of choice. It is adaptable to a wide range of healing conditions and its absorbability prevents it from acting as an infected foreign body. Rest of the injured part is best provided by immobilization in plaster. This also facilitates transportation of the patient, alleviates pain, and tends to reduce shock.

Discussions of eleven subjects in this series on Suture Use have been published. Reprints (including the above) and a bibliography will be sent on request.
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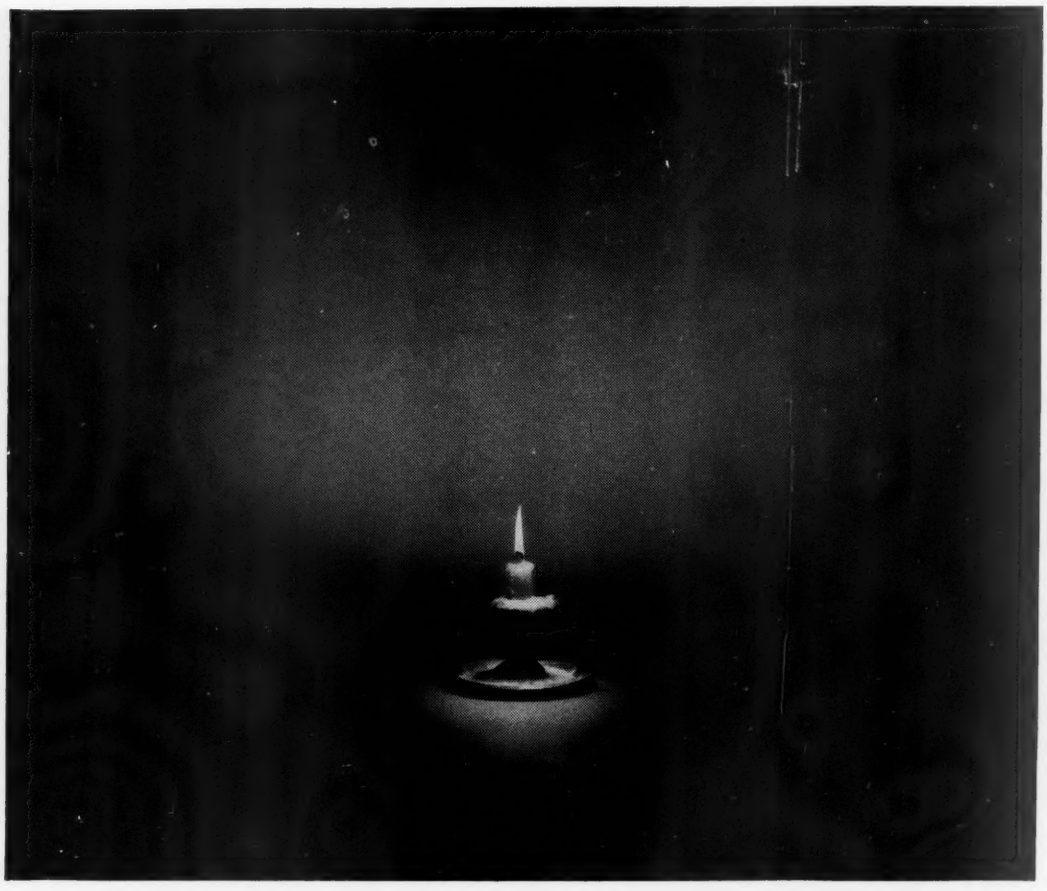

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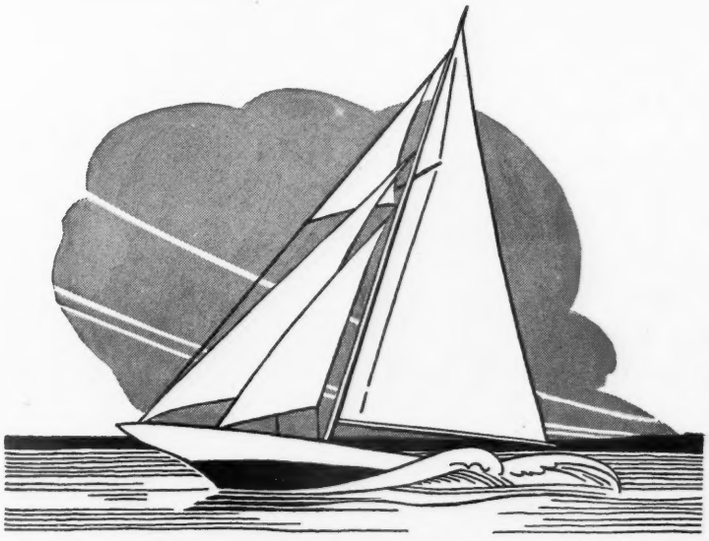

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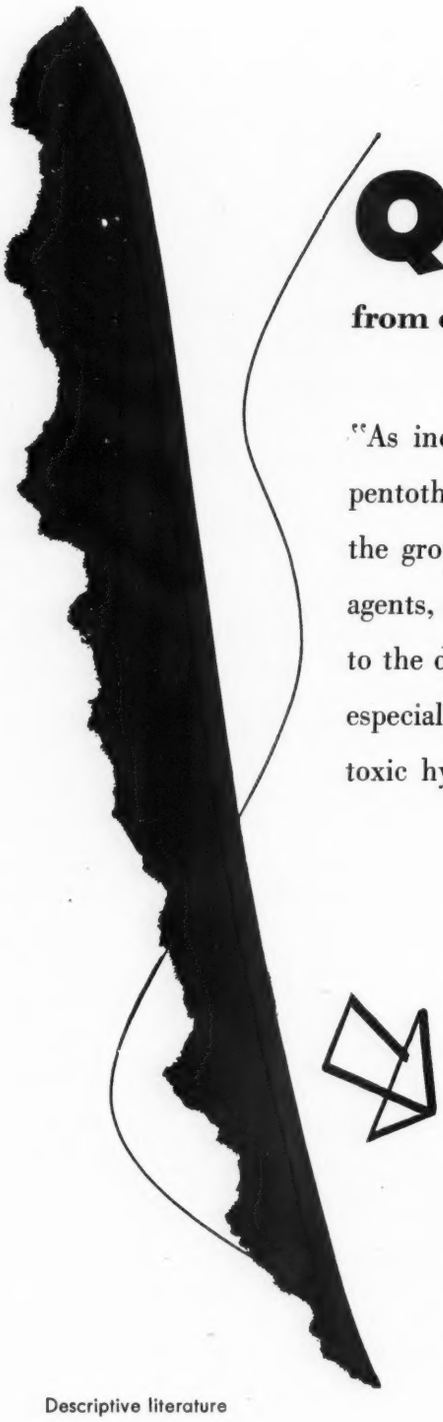

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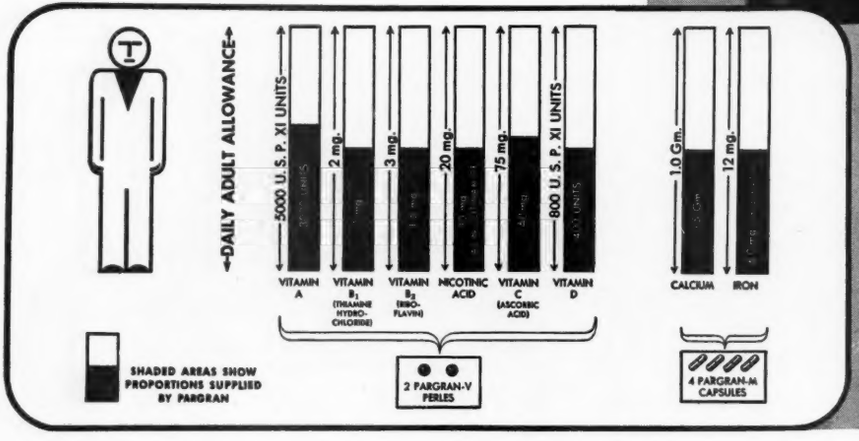

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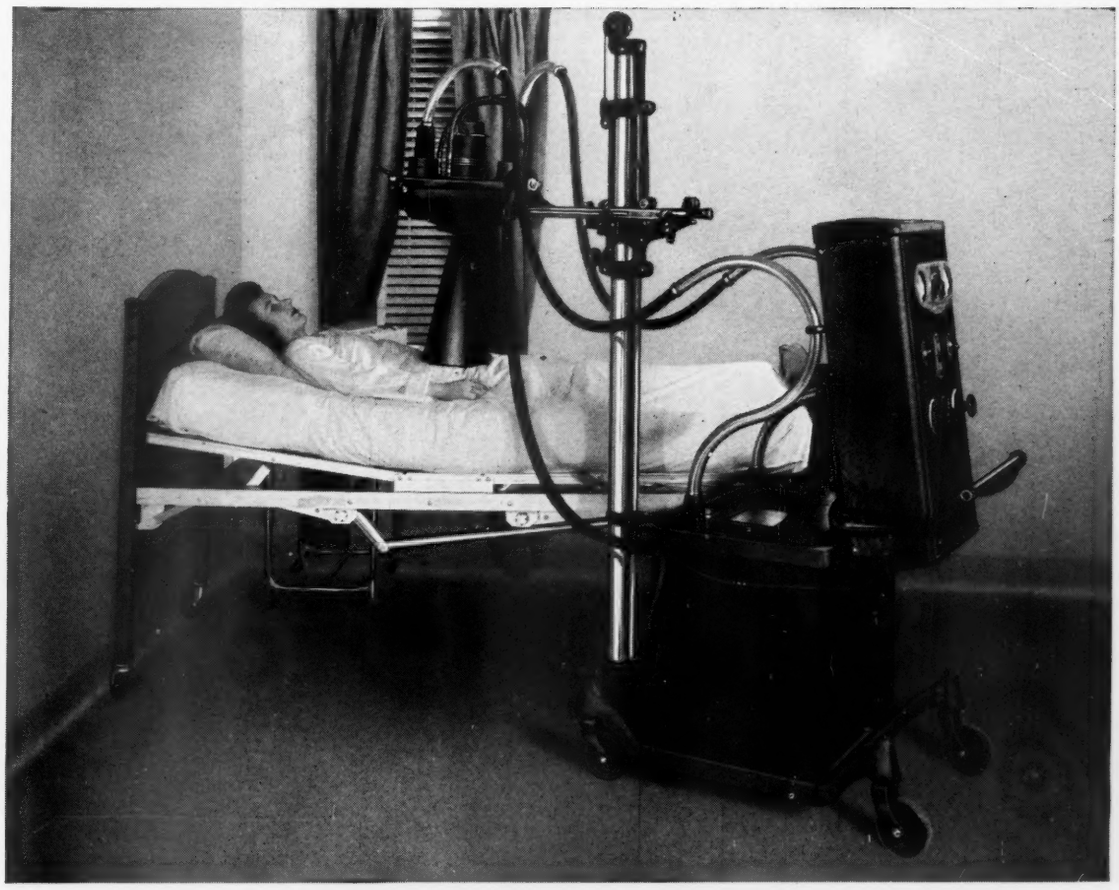

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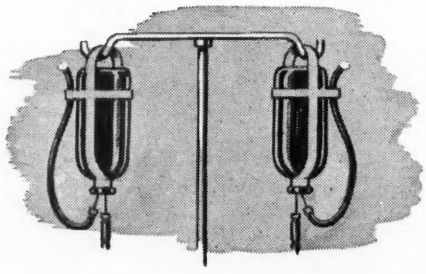

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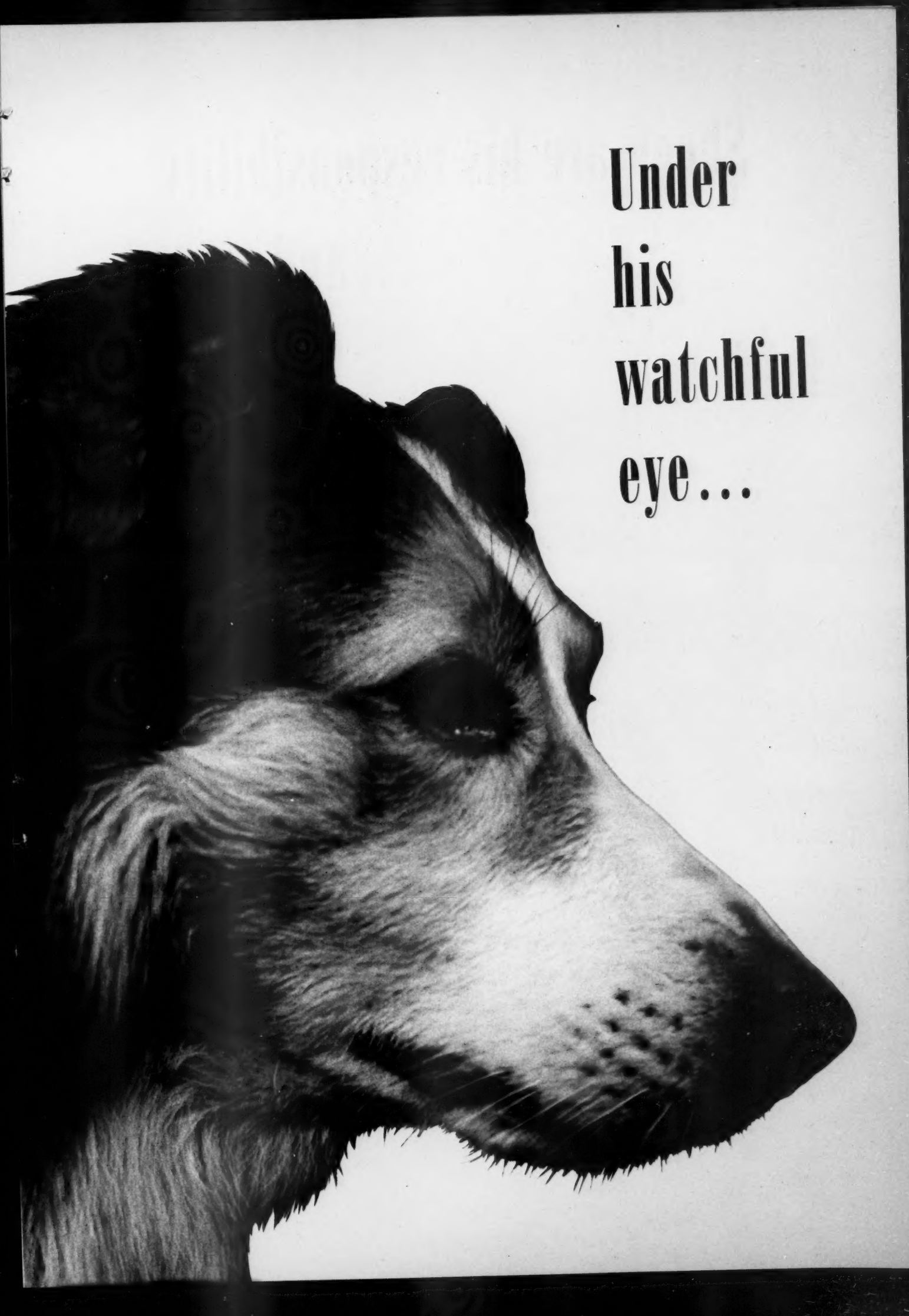
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Editorial

ECONOMIC SECURITY AND PROFESSIONAL STANDARDS

HAPPINESS is largely dependent upon economic security. Financial difficulties interfere with development. Worry incident to the source of sufficient revenue to enable the student to devote himself wholeheartedly to his studies diminishes his capabilities for the future doctor.

In these days of world revolution the evolutionary process of standards is definitely threatened. No group is more threatened than the medical profession. Ethical standards, educational opportunities, and the relations of the profession to the public are in a state of flux.

Can we maintain the ideals which have characterized the development of our profession, or will we be caught in the maelstrom of the present world catastrophies? I believe that we can maintain our position with dignity and honor, but only by the greatest effort. The responsibility of the leaders at this time is particularly heavy. Precepts and examples are essential to the maintenance of ideals.

The doctors of the immediate future will become part of the great army to protect human rights and liberties. No greater privilege can come to any man than to participate in this struggle for the preservation of those democratic ideals set forth in our Constitution. In the confident hope that victory will crown our efforts let us not lose sight of what is being fought for. Many men will, when the struggle is over, be satisfied to retain the financial security of the paternalism of government service. This very complacency on the part of the profession would inevitably lead to a socialized system of medicine.

It is urgent, therefore, that the teachers of medicine should urge upon the prospective doctor the importance of his normal relations to the public in the private practice of medicine. This relation should remain personal in character. To make of the *Doctor* a *Job Holder* would place the profession in a category unbecoming to the responsibilities involved.

Fortunately, in our country we divide the duties of the citizen into three categories: allegiance to God, Country and Family. Only one of these is collective—our duty to our native land; under the constitution the other two obligations are individual in character.

This basic triad differentiates democratic institutions from totalitarian philosophies. Cultivation of the ideals of individual responsibility is bound to strengthen a people, to increase initiative and lead to progress in every field.

The development of medicine is a record of individual endeavor. Inspired by the leadership of pioneers progress has been made and will continue to be made. Dreams, hopes and ambitions are the stuff out of which initiative and effort synthesizes progress. Controlled activity stifles initiative.

The pages of history record eloquently the names of men, not governments, whose efforts are responsible for the present noble positions in the diadem of world accomplishments in the profession of medicine. No revolution of any kind can ever efface the good accomplished by Hippocrates, De Chaulliac, Pare, Lister, Long, Morton, Pasteur, Percival and a host of individuals who did things.

Progress in medicine is bound up with individual effort and initiative sustained by ideals of service to the human family. The ideals of service must continue to stimulate the professional scion as well as the neophyte.

The teacher must never forget that his example is a pattern for his students. Nobility of purpose, devotion to duty and sympathetic understanding of the sick should characterize his every action. Personal aggrandizement and publicity are not qualities to be admired or condoned in teachers. It is well to be reminded of Emerson's epigram: "Character is above intellect."

In professional life the most desirable attribute is character. In order to maintain the character of the professional it is especially desirable that great care be exercised in the acceptance of the mass of students who would be doctors. Adequate weeding out of undesirable students will eliminate those whose background is not sufficient to enable them to withstand temptations to which the lean years would expose them.

We are all familiar with the monstrous practice known as fee splitting. The cause of this pernicious habit must fundamentally be due to lack of character and lack of moral appreciation of the responsibility involved in the care of the sick. Bartering patients is a betrayal of trust. It is a means utilized by conscienceless and unscrupulous individuals who have gained entrance into the professional field. It is a prostitution of professional standards. With economic stress, one may expect to find that certain individuals or groups will stoop to low and unworthy practice. It is the duty of every one to see that betrayal of faith by some does not reflect on the honor and glory of our calling.

Maintainence of standards of conduct, insistence on proper appreciation by the public of the service of the profession and appreciation of our opportunities to serve the cause of human welfare, will bring contentment even in times of change.

Isidore Cohn, M.D.

Original Articles

MANAGEMENT OF CEREBRAL TRAUMA*

ELLIOTT C. CUTLER, M.D. AND ROBERT D. WHITFIELD, M.D.
Mosely Professor of Surgery, Harvard Medical School
BOSTON, MASSACHUSETTS
Assistant in Surgery, Albany Medical School
ALBANY, NEW YORK

THIS is a report of our experience with 396 consecutive cases of craniocerebral injury admitted to the Peter Bent Brigham Hospital during the years 1913 to 1939 inclusive. It concerns only the immediate management of the acute problem and does not represent fully the end result in this field. Only acute cases seen in this clinic within the first twenty-four hours have been included, and most of the patients were brought directly to the emergency room from the scene of the accident.

The one unvarying criterion for the acceptance of a case for review has been that the patient was unconscious following trauma. We have insisted that the record establish that the patient was either unconscious at the time of or after admission or was reported by a reliable observer to have been unconscious before admission. Other than this there has been no selection of cases whatsoever—all from the least to the most severe have been included. Careful consideration of the individual cases has shown that in a large proportion the degree of amnesia is greater and its duration considerably longer than the duration of unconsciousness.

We have been impelled to review these cases by the growing importance of the problem today. In the year 1936,[18] there were 110,000 fatal accidents in the United States of which 34 per cent were due to motor vehicles. Fifty per cent of the latter were craniocerebral injuries. The question of the best management of these injuries during the acute phase is, therefore, one of pressing urgency.

There exists at present much difference of opinion as to the preferable management. For many years the primary consideration has been the control of the increased intracranial pressure consequent upon the injury. It has been recognized that the damage done to the cranial bones is of small moment unless these be driven inward or a compound fracture exists. The paramount consideration is the injury to the underlying brain. In this connection we wish to point out that injuries caused by rapidly moving objects, such as automobiles, are far more likely to result in damage to the intracranial contents than to the cranium, while those caused by slowly moving objects frequently result in a bursting type of injury with comparatively little damage to the brain and its coverings.

The problem of injury to the brain derives its peculiar qualities from the fact that this organ rests within a closed box surrounded by the tough fibrous dura matter and the filmy pia-arachnoid with the contained cerebrospinal fluid. The injured brain itself reacts in the familiar way in which all the bodily tissues react when damaged. The injury may be manifested simply by edema, by minute capillary hemorrhages, or by the formation of large hematomas with disruption of substance. If it were not for the inexpansible

* From the Surgical Clinic of the Peter Bent Brigham Hospital, Boston, Massachusetts.

space, the healing of the injured tissue would be simply the problem of repair, specialized as this is within the central nervous system.

But room must be made for the expanding brain at the expense of whatever may be dispensed with. Cushing,[5] many years ago, pointed out that during acute cerebral compression, certain definite changes occur in the clinical picture as the result of alteration in the blood flow within the cranium. These observations have been so repeatedly confirmed that they are generally accepted as of great prognostic significance in following a case of craniocerebral injury.

In the first stage of compression the blood supply to the vital centers in the medulla becomes gradually reduced to the point at which anoxemia of the circulatory and respiratory centers causes, through the vagus nerve, a slowing of the cardiac and respiratory rates. This is known as the period of *compensation*. In this stage there is a characteristic bradycardia and less often a slowing of the rate of respiration and vomiting. A complete physiological understanding of the mechanism of vagal response to anoxemia is wanting, but we know that, as anoxemia is induced, the vagus becomes more active, for once the heart rate has been depressed, section of the vagus brings about a more rapid rate. When the compression is further increased to the point where inadequate oxygenation of the medullary centers occurs, the pulse rate becomes still slower and the blood pressure begins to show a rise in the systolic and fall in the diastolic pressure. This is interpreted as a compensatory effort by the general systemic circulation. At this point the pulse rate tends to become alternately rapid and slow. Finally, when the period of decompensation is reached, the pulse rate, respiratory rate, and pulse pressure may simultaneously rise to progressively higher levels with eventual death. Associated with these phenomena is a rise in temperature, presumably due to the effect of the increased intracranial pressure on the temperature regulatory mechanism.

The essential feature is, therefore, the control of the increased intracranial pressure. There are three variable factors: One, to which we have already alluded, is the volume of blood within the cranium. The second is the volume of the cerebrospinal fluid. The third is the volume of the brain tissue itself.

The cerebrospinal fluid[14] is formed within the lateral ventricles by the choroid plexus. Its flow is thence through the foramina of Monro into the third ventricle, thence through the Sylvian aqueduct to the fourth ventricle and out through the foramina of Luschka and Magendie. Some fluid then circulates downward around the spinal cord and back to the great cisterns at the base of the brain. The flow from these is upward over the surface of the cerebral hemispheres to the arachnoidal villi through which readsorption takes place into the great venous sinuses.

The third variable factor is the volume of brain tissue itself. The acutely injured brain often becomes edematous, due to cellular reaction and extracapillary fluid, and its volume therefore increases. It is this increase, and in addition whatever increase is caused by the formation of hematomas, which is primarily responsible for the rise in intracranial pressure.

The whole problem of management lies in the ability of the surgeon to control one or more of these variable factors and therefore to keep the intracranial pressure reduced to a safe level. In the event of failure by conservative measures, removal of bone from the cranial vault accomplishes this purpose. This is usually done by removing the squamous portion of the temporal bone by the operation known as subtemporal decompression. Such a procedure must be performed before the cerebral ischemia has been long established, since few tissues are as sensitive to anoxemia as these.

In 1921, Weed and Hughson[23] proposed the use of hypertonic solutions to reduce intracranial pressure by the osmotic withdrawal of fluid from the edematous tissue.

At first hypertonic saline (sodium chloride) was utilized by intravenous infusion, but it was soon found that numerous petechial hemorrhages followed its use. Consequently 50 per cent glucose intravenously began to be used instead and was the agent of choice for many years. It was known, however, that a secondary rise in intracranial pressure occurred after its use, possibly due to glucose being absorbed by the brain tissue and thus reversing the osmotic flow.

In 1935, Gregerson and Wright[9] established the superior value of hypertonic sucrose for this purpose, and Jackson and his co-workers,[11,12] in 1937, reviewed the clinical use of this sugar when administered intravenously and reported excellent results. Theoretically, this is a more desirable agent than glucose because it does not pass the blood-brain barrier and there is no secondary rise of intracranial pressure. The efficacy of dehydrating agents has been seriously questioned by other workers, among whom are Browder and Meyers.[4]

In addition to the use of dehydrating agents intravenously, the limitation of fluid intake, with or without general dehydration by watery catharsis induced by magnesium sulfate orally or rectally, is widely practiced. Fay[8] reviews his results with this mode of treatment over a long period of time and reports a final mortality of 13.8 per cent. He points out that overdehydration is to be avoided.

In contrast to this is the vigorous hydration with repeated lumbar punctures practiced by Munro.[17] He avoids dehydration because he believes that the physicochemical equilibrium of the brain tissue is so severely upset by withdrawal of fluid and vigorous purging that more harm is done than good. If fluid intake is kept far above the normal daily intake, however, the intracranial pressure rises and other measures must be taken to control it. For this he uses repeated lumbar punctures.

Dandy[6,7] also eschews fluid limitation but does not force fluids above normal daily intake. He avoids dehydrating agents and vigorously condemns lumbar puncture, even for diagnostic purposes. The reason for this condemnation is that there is inherent danger in lumbar puncture in the presence of increased intracranial pressure, unless the pressure is first relieved from above, because the brain may be so forced down into the foramen magnum by the existing pressure that a sudden release from below may jeopardize life. This contraindication is of sufficient importance in Dandy's mind to militate against the lumbar puncture even for diagnosis, since his experience has shown that careful observation of the patient's clinical condition will yield all the information available from diagnostic puncture. If in spite of rest the patient fails to improve, he advocates subtemporal decompression. Penfield[19] has voiced his objection to the use of lumbar puncture in patients with increased intracranial pressure, twitting the proponents of this point of view by calling them "picadors!" The danger is perhaps not widely appreciated.

Our own plan of treatment, in recent years at least, pursues a middle course. We view the problem of treatment as essentially one of restoring the normal physiological balance of the injured brain as early as possible. For this reason the paramount consideration is rest, which we seek to have consist of complete bed rest for one full week after all symptoms have disappeared. For the first few days after the injury we limit fluids moderately, usually to less than 1,500 cc. daily, occasionally to less than 1,000 cc. daily, with the occasional use of magnesium sulfate catharsis. However, we do not carry dehydration to the point at which systemic effects appear.

Patients in whom the diagnosis is doubtful, and all definitely, but slightly injured patients—in other words those who do not have greatly increased intracranial pressure—are submitted to lumbar puncture shortly after admission. The spinal fluid pressure is determined with the Ayer water manometer, no Queckenstedt test being performed, followed by withdrawal of 2 cc. of cell count and globulin determination by the Pandy

or ammonium chloride tests. We believe that when the lumbar puncture is carefully done by an experienced person, it is safe.

Severely injured patients, however, are not submitted to lumbar puncture until the immediate danger is passed. *X*-ray films of the skull are taken at some time during the patient's hospital stay for medicolegal reasons; but unless palpation raises the question of a depressed fracture of the skull, the taking of *x*-ray films is delayed until the patient's condition has been stabilized.

So far we have discussed only uncomplicated concussion and contusion of the brain. In the event that definite evidence of acute extradural or subdural hemorrhage is present, or if there is a compound fracture of the skull, operative intervention has been our practice in common with other clinics.

The subsequent tables demonstrate the material studied, the methods of therapy and immediate results achieved.

GENERAL MORTALITY STATISTICS (TABLE I)

Table 1 reviews the general statistical evidence in the field of cerebral trauma between the years 1913 to 1939, that is, the period in which we have studied its management. Because of changes in the methods of therapy for this condition during this period of time, we have broken down the evidence by nine-year periods. In Table 1 our own figures are set up in comparison to the figures submitted by authors working on this problem in the corresponding nine-year period. Note that in the first nine-year period, 1913 to 1921, the mortality figures vary roughly from 25 to 50 per cent. This was a period characterized by the greater use of the surgical means of treatment than is now generally advocated. When one comes to the second nine-year period, 1922 to 1930, the mortality figures are all substantially lower, varying from 11 to 37 per cent. During this interval as a whole the surgical treatment of all patients with intracranial damage came into discredit with a large fragment of the medical profession, and possibly a further factor in the reduced mortality rate was the reintroduction of dehydration as a method of therapy. When we come to examine the last nine-year period, 1931 to 1939, we notice again a further falling off in the mortality rate. There may be several factors which caused this reduction: (1) A further diminution in the amount of surgery performed; (2) a more widespread use of dehydration methods, and finally (3) a

TABLE I

COMPARISON OF MORTALITY STATISTICS

	Cases	Mortality
Besley (1916)[2]	1000	53.0 %
Sharpe (1916)[20]	239	30.7%
Wilensky (1919)[24]	72	31.0%
Moorhead and Weller (1921)[15]	100	26.0%
Stewart (1921)[21]	6135	52.0%
AUTHORS (1913-1921)	63	26.98%
Bower (1923)[3]	62	26.1 %
Heuer (1924)[10]	223	35.8 %
Kennedy and Wortis (1926-1929)[26]	1000	37.8%
Beekman (1921-1926)[1]	331	11.4%
Mc Clure and Crawford (1927)[13]	441	14.7%
AUTHORS (1922-1930)	93	11.83%
Swift (1935)[22]	112000	25.0 %
Munro (1930-1933)[16]	1450	17.5 %
Fay (1927-1932)[8]	528	20.0%
Woodhall (1936)[25]	300	18.66%
AUTHORS (1931-1939)	240	7.92%
AUTHORS (Total 1913-1939)	396	11 87%

realization both by the people and the profession of the seriousness of cerebral damage, a large proportion of which occurs in automobile accidents. A good many more patients suffering from the less serious types of intracranial damage were hospitalized and therefore available for study. It was the considerable drop in our own mortality statistics and the discovery that our figures were now perhaps lower than those usually reported that led us to present this study at this time. The drop in our own mortality from 26.9 per cent in the first period to 7.9 per cent in the last period is significant and has led us to try to evaluate the reason for this.

TABLE II

MATERIAL AND MORTALITY

YEARS	Group A		Group B		Group C		Total	
	Cases	Mortality	Cases	Mortality	Cases	Mortality	Cases	Mortality
1913-1921	18	2*	25	1*	20	14	63	17
	28.57%	11.1%	39.68%	4.0%	31.75%	70%		26.98%
1922-1930	39	0	36	0	18	11	93	11
	41.94%	0%	38.71%	0%	19.35%	61.1%		11.83%
1931-1939	110	0	89	3+	41	16	240	19
	45.83%	0%	37.08%	3.4%	17.08%	39.0%		7.92%
Total	167	2	150	4	79	41	396	47
	44.41%	1.2%	37.88%	2.6%	22.73%	51.9%		11.87%

* Due to non-cerebral causes.
+ Two of these due to non-cerebral causes

AUTHOR'S MATERIAL AND MORTALITY STATISTICS (TABLE II)

In Table II we have attempted a more complete analysis of our own material, again breaking the periods for study into nine-year intervals in order that any change in therapy might be evaluated if a significant drop in the mortality rate occurred. For each nine-year period we have broken down figures into separate groups according to the severity of the damage as already outlined. Group A includes those unconscious for less than fifteen minutes; group B those unconscious from fifteen minutes to twenty-four hours, and group C, the seriously damaged patients, those unconscious longer than twenty-four hours as well as those with extradural and subdural hematomas and compound fractures of the skull. The mortality in the period 1913 to 1921 inclusive was 26.98 per cent. This fell to 7.92 per cent in the period 1931 to 1939 inclusive in spite of a rise in the total number of cases from sixty-three for the first period to 240 for the last. During this time, however, the relative proportion of severely injured patients fell sharply from 31.75 per cent in 1913 to 1921 to 17.08 per cent in 1931 to 1939. But the mortality in the severe cases has remained consistently well above 40 per cent until 1931 to 1939 when it fell to 39 per cent. The drop in the percentage of severe cases is only of fairly probable mathematical significance as the difference lies between two and three times its standard error, whereas the decrease in the gross mortality percentage is over four times its standard error, and the decrease in the mortality percentage of the severe cases is five times its standard error. Thus the decreases in the mortality percentage are of definite unequivocal mathematical significance.

SURGICAL THERAPY (TABLE III)

In Table III we have attempted to evaluate the efficacy of surgical therapy. During the first nine years of the study its incidence was above 52.38 per cent, whereas it has since then fallen sharply, dropping to 15.05 per cent during the period 1922 to 1930, and then to 13.75 per cent in 1931 to 1939. In the earlier years many of the

moderately injured group were operated upon. At the present time our indications for operation are: (1) Increasing coma after a period of several hours observation; (2) the appearance of focal neurological signs indicating a rapidly growing extradural or acute subdural hematoma; (3) failure to improve after forty-eight hours of conservative treatment; (4) compound fractures of the skull, which are immediately débrided and sutured, depressions being replaced at the same time (other depressed fractures are not operated upon until the recovery period is fairly well advanced). We are here referring, of course, to cranial operations. Surgical intervention for other traumatic injuries takes place at the time imposed by the urgency of the indications.

TABLE III

SURGICAL TREATMENT

YEARS	Exploration or Decompression	Elevation Depressed Fracture	Encephalography or Ventriculography	Total Operations	Total Cases	% Operations	% Total Mortality	% Severe Cases	% Mortality Severe Cases
1913-1921	29	4	0	33	63	52.38	26.98	31.75	70.0
1922-1930	9	5	0	14	93	15.05	11.83	19.35	61.1
1931-1939	21	7	5	33	240	13.75	7.92	17.08	39.0
Total	59	16	5	80	396	20.20	11.87	22.73	51.9

The operation most often performed has been subtemporal decompression. If focal signs were present, it was of course performed on the side indicated; if they were not, the right side was always elected in right-handed persons. In a considerable number of instances, bilateral subtemporal decompressions were done, and in a few patients with considerable evidence of advanced pressure with marked medullary embarrassment suboccipital decompressions were chosen.

It is noteworthy that the significant drop in the percentage of operations performed occurred at the same period as the significant drop in the gross mortality percentage and undoubtedly has a bearing upon it, whereas the significant drop in the mortality percentage of the severely injured patients did not occur until nine years later and must be related to factors other than surgical therapy.

DEHYDRATION THERAPY (TABLE IV)

Dehydration first began to be employed in 1922 shortly after the value of dehydrating agents in patients with increased intracranial pressure was pointed out. Magnesium sulfate orally or rectally has been used since that time, but other agents, such as intravenous glucose and sucrose, have been employed only six times in the last six years. At no time, however, have more than 36 per cent of the total number of admissions in the series received these drugs. The incidence of use has risen from 20.43 per cent in 1922 to 1930, to 31.67 per cent in 1931 to 1939.

Associated with this has been limitation of fluid intake since 1925. No figures are available in the records as to the fluid intake before that date. There is a definite tendency since that date toward stricter dehydration by limitation of fluid intake. In the period 1925 to 1930 only 15.38 per cent of those patients on whom a record of fluid intake is available received less than 1,000 cc. daily and 46.15 per cent over 1,500 cc. In the period 1931 to 1939, however, these respective figures are: 32.91 per cent below 1,000 cc., 36.18 per cent between 1,000 and 1,500 cc., and 30.92 per cent over 1,500 cc. In short, at the present time 69 per cent of these patients have some limitation of fluids. The remainder, on whom no figures are available, are those who were detained only twenty-four hours or less,

and all come within the mildly injured group, save for an occasional patient who died shortly after admission.

cerebral trauma, particularly in a clinic where the responsible surgeon often has no opportunity personally to verify the fact of

TABLE IV

EFFECT OF DEHYDRATION

A Magnesium Sulphate by Mouth or Rectum

Years	Total Cases	Number Cases in which used	% Cases in which used	% Total Mortality	% Group C Cases	% Mortality Group C
1913-1921	63	0	0	26.98	31.75	70.0
1922-1930	93	19	20.43	11.83	19.35	61.1
1931-1939	240	76	31.67	7.92	17.08	39.0
Total	396	95	23.99	11.87	22.73	51.9

B Restriction of Fluid Intake

Years	Total Cases	Number Cases Fluid Restricted	% Cases 1000cc	1000-1500cc	Above 1500cc	% Total Mortality	% Severe Cases	% Mortality Severe Cases
1913-1921	63	0	0	0	0	26.98	31.75	70.0
1922-1930	93	26	4 4.30%	10 10.75%	12 12.90%	11.83	19.35	61.1
1931-1939	240	152	50 20.83%	55 22.92%	47 19.58%	7.92	17.08	39.0
Total	396	178	54 30.34%	65 36.51%	59 33.14%	11.87	22.73	51.9

The differences in the percentage of cases in which strict and moderately strict dehydration was employed are in all instances greater than twice the standard error of the difference, and with one exception all are from five to ten times that standard error. Therefore, the increasing use of this method of treatment in our series is mathematically true and may be correlated with the drop in the mortality percentage, both gross and with regard to the severely injured patient.

USE OF LUMBAR PUNCTURE (TABLE V)

Throughout the series the use of lumbar puncture as a diagnostic procedure has held a significant place which has increased in frequency. In the period, 1913 to 1921, it was employed in 32 per cent of the total admissions; while in 1931 to 1939 75 per cent were submitted to it. Indeed in recent years it has become increasingly difficult to emphasize to the house staff that the presence of erythrocytes in the cerebrospinal fluid is of somewhat less importance than a definite history of unconsciousness and the presence of retrograde amnesia. We believe, however, that the procedure offers valuable confirmatory evidence of cranio-

unconsciousness, especially if this be short-lived. Moreover, as carried out here we believe it to be safe. In the severely injured patient it is undertaken only on the direct and personal authorization of a senior resident or a member of the senior staff; in the mild cases, the emergency ward man or ward house officer routinely performs it, but only as restricted by a definite method.

This increase in the percentage of cases in which diagnostic lumbar puncture was employed is mathematically significant, for it is seven times its standard error. Since it was associated with a significant drop in the mortality percentage, we may say that the procedure is safe. Obviously a diagnostic procedure such as this cannot contribute *directly* to that reduction.

Lumbar puncture as a method of treatment we mention only to decry it. It was first so used here in 1922. The incidence of its use rose from 0.0 per cent in the period 1913 to 1921, to a maximum of 11 per cent in 1922 to 1930, falling to 3 per cent in 1931 to 1939. There is at least one fatality (1923, Surg. No. 18910) directly attributable to its use. This patient, though moderately severely injured, presented a vivid and sudden change for the worse immediately

following the withdrawal of 25 cc. of bloody cerebrospinal fluid, showing rapidly increasing medullary embarrassment.

injured patients and in a considerable number of the severely injured.

3. Traumatic shock, if present, is invariably treated before the patient is moved from the emergency room to the ward.

4. *X*-ray films of the skull, while made in every case for medicolegal reasons, are postponed until the added trauma of extra handling and moving will no longer adversely affect the patient.

5. Rest in bed for one week after subsidence of all evidences of increased intracranial pressure with gradual resumption of activity thereafter.

6. Mild dehydration for three days, rarely longer.

7. Operative intervention for the definite indications previously mentioned.

TABLE V

USE OF LUMBAR PUNCTURE

YEARS	Diagnostic	Therapeutic	%Mortality Group C
1913 1921	20	0	70
	32%	0%	
1922-1930	16	10*	61.1
	17%	11%	
1931-1939	180	6	39.0
	75%	3%	
Total	216	16	
	55%	4%	

*One fatality in this group

The differences between the percentage of use of the therapeutic lumbar puncture in the middle period of the study and that in either the first or last period are mathematically significant, being over eight times the standard error. There is no significant difference between the first and the last period. The eventual abandonment of this method occurred simultaneously with the drop in the mortality percentage of the severe cases.

PLAN OF TREATMENT

During the early years of the period covered by this study most patients admitted with craniocerebral injuries were cared for on the general surgical service, the essentially separate neurosurgical service seeing those who seemed to need operative intervention. Since 1932, all these patients have been the direct responsibility of the senior author, and have been cared for by him with the assistance of the assistant resident surgeon assigned to him personally. In this period a definite plan of treatment has been adopted.

The essential points of this are as follows:

1. All patients with a definite history of unconsciousness or amnesia following an accident are hospitalized.

2. Diagnostic lumbar puncture is performed in all the mildly and moderately

SUMMARY

1. We have reviewed a series of 396 consecutive cases of craniocerebral injury admitted to the Peter Bent Brigham Hospital during the years 1913 to 1939 inclusive, of which 44.41 per cent were mildly injured, 37.88 per cent moderately injured, and 22.73 per cent severely injured.

2. The gross mortality for the entire series was 11.87 per cent; for the mild cases, 1.2 per cent; for the moderately injured cases, 2.6 per cent; and for the severely injured cases, 51.9 per cent. The mortality for all cases has decreased from 26.98 per cent in 1913 to 1921 inclusive, to 7.92 per

cent in 1931 to 1939 inclusive, but in the severely injured cases has remained constant.

3. The incidence of operative intervention has been reduced from 52.38 per cent to 13.75 per cent from the former period (1913 to 1921) to the latter period (1931 to 1939).

4. Mild dehydration therapy has been employed with steadily increasing frequency. From 1931 to 1939 inclusive 42 per cent of patients had some limitation of fluid intake and 31.67 per cent received large doses of magnesium sulfate orally or rectally.

5. Diagnostic lumbar puncture has been utilized more and more frequently, up to 75 per cent of all cases from 1931 to 1939 inclusive; therapeutic lumbar puncture has been abandoned.

6. A general plan of treatment as used by us at present is described.

CONCLUSIONS

The treatment of craniocerebral injuries by complete rest, and an attempt to restore the physiological equilibrium as quickly as possible are shown to be safe and efficient means of managing these injuries. Accurate history, painstaking examination of the patient and conscientious observation of his course are absolutely essential. Judicious use of lumbar puncture as a diagnostic aid is often advantageous, but its therapeutic use is to be condemned. Mild dehydration during the period of immediate recovery is helpful but should not be carried to excess. Operative intervention is necessary in a small number of cases but only on definite indications; the surgeon, however, should be prepared to offer it when indicated and not be misled into conservative management beyond the point of safety.

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ACUTE INTUSSUSCEPTION IN INFANCY*

A. J. CAPONE, M.D.
Assistant Visiting Surgeon, Somerville Hospital
SOMERVILLE, MASSACHUSETTS

THE purpose of this paper is to emphasize the diagnostic points of acute intussusception, to review the literature regarding the nonoperative and operative treatment with their advantages and to present several personal cases that have received treatment.

DIAGNOSIS

The diagnosisis made on a careful history obtained from the mother, who usually relates that the child was perfectly well and healthy until seized by a sudden, acute pain that caused the child to cry vigorously, but that the baby would have spells of entire quiet from five to ten minutes between paroxysms; that there were one or two normal bowel movements followed by bloody mucus resembling currant jelly. Vomiting occurred early and was a prominent symptom.

A physical examination may reveal a child that does not seem acutely ill when seen early, and especially if seen between paroxysms. There is no rise in temperature, skin may be moist and cold, pulse rapid, abdominal examination may find it relaxed with tenderness and moderate spasm to the right lower quadrant with or without finding of a doughy tender mass that is movable.

Rectal examination is to be emphasized as being most important since the finding of blood on the examining finger is practically a criterion of this condition. One must note, however, that the most common error is to regard the case as one of gastroenteritis, the physician's attention being engrossed by the vomiting and bloody stools. *X*-rays have been employed in substantiating the diagnosis since a barium enema may demonstrate a narrowing or a complete blockage at the ileocecal valve.

DIFFERENTIAL DIAGNOSIS

One must consider acute appendicitis, enterocolitis, rectal prolapse, a bleeding Meckel's diverticulum, and lastly, abdominal Henoch's purpura.

1. *Acute Appendicitis.* Here there is fever, spasm, elevation of white count; the onset is not as acute as in intussusception and the history of shock is not obtained as regularly. There is usually nausea for a day followed by abdominal pain. In appendicitis there is no mass early; if there be a mass, it would appear in a week or ten days after the acute attack and would represent localized appendiceal abscess. It is a known fact that acute appendicitis under the age of two is uncommon.

2. *Enterocolitis.* This condition rarely has the sudden onset of intussusception and it is associated with an excessive number of loose watery stools with or without mucus and blood. Here feces and flatus continue to pass and this is not the case in obstruction of intussusception. No mass is palpable. There is no paroxysm of pain as one would see in intussusception. If there be vomiting, it is much less than in intussusception and is not associated with other symptoms of developing obstruction. It is wise to note, however, that enteritis with its hyperperistalsis may lead to intussusception.

3. *Rectal Prolapse.* This condition is in itself easily recognizable by the rectum coming into view. It may be easily differentiated from a prolapsed intussusception by the fact that one cannot pass a finger into the rectum alongside the protruding mass if it is a rectal prolapse.

4. *Meckel's Diverticulum.* The history is somewhat similar to that of appendicitis; the temperature is elevated along with the

* From the Department of Surgery, Somerville Hospital, Somerville, Massachusetts.

white blood count. Here, however, one must note that a Meckel's diverticulum is one of the predisposing causes of an intussusception.

5. *Abdominal Henoch's Purpura.* Differentiation in this condition may be difficult inasmuch as in abdominal purpura one may have a sudden onset with severe pain and associated shock along with the passage of blood per rectum and frequently the presence of an abdominal mass due to subserous extravasation of blood along the bowel. The differentiation would be noted as follows since the symptoms of abdominal Henoch's purpura are: (*a*) A purpuric rash over the body, most frequently on the extensor surfaces of the extremities; (*b*) a good test is to apply a tourniquet to the arm for a few minutes to produce distal petechial hemorrhages; and (*c*) low platelet count.

TREATMENT

There are two schools of thought regarding treatment: (1) nonoperative followed by surgery if not successful, and (2) operative treatment as soon as the diagnosis is determined.

Nonoperative Treatment. Hipsley, of Australia, has reported in many articles over 200 cases. His method is to employ hydrostatic pressure of saline solution into the rectum since he believes that 60 per cent of cases can be reduced with this technic which is briefly as follows:

The infant is given a general anesthetic. A No. 16 catheter is placed up high into the rectum and both buttocks are pinched over the catheter so as to prevent any reflux of fluid. The irrigating can is placed three to four feet above the patient and one quart of saline solution is allowed to run in by gravity. The pressure is held in this manner for three minutes, then allowed to escape. This procedure is repeated several times. Hipsley notes that the abdomen should not be palpated while the fluid pressure is on because of the danger of rupturing the weakened intestinal wall. The difficulty is to be sure of complete reduction of the intussusception and he gives the following as evidences of reduction:

1. *Abdominal distention* following the giving of the enema demonstrates that the fluid has passed into the small bowel past the tumor with resultant reduction of the mass.

2. *Alteration in the Circumference of the Abdomen.* A successful reduction of the tumor mass shows an increase of approximately two inches about the umbilicus after the reduction.

3. *Yellow Fecal Material in the Returned Saline Solution.* The first or second return of saline solution may demonstrate some amount of blood. If after these first injections, there is a return of fecal material, it clearly demonstrates that this has come down proximal to the tumor mass.

4. *Flatus in the Return.* This likewise would demonstrate reduction of the tumor mass since the flatus would necessarily have to come proximal to the mass. *X*-ray filling of the small intestine after an opaque injection of barium has been used instead of saline. Here the presence of barium in the small bowel clearly indicates a reduction.

5. *The Use of Charcoal to Varify Reduction.* In an infant seen during the early stage of this disease where there is considerable doubt as to the diagnosis, one could easily ascertain whether or not there is obstruction at any point along the bowel tract by giving the child a teaspoonful of powdered charcoal mixed in a half ounce of water by mouth. Normally, this will be passed by rectum from within five to seven hours if there is no obstruction.

Hipsley notes that he continues the treatment with surgery if he is not certain of complete reduction, and states that he never employed this treatment after twelve hours of the acute seizure.

Retan and Stephens further elaborate the hydrostatic pressure treatment of Hipsley by introducing rectally a barium mixture and observing its action under the fluoroscope. The method is as follows:

The barium mixture is introduced with minimal pressure until the colon is filled to

the advancing point of the intussusceptum (the enema source is held between two and three feet above the level of the patient); then with the pressure gravity shut off, the barium is forced against the intussusceptum by manual pressure externally on the already filled colon under visual guidance and control. As the intussusceptum recedes, more of the mixture is introduced and the manual pressure again applied. As soon as the intussusception seems reduced the colon is completely filled by gravity pressure to make certain that the reduction is complete; if such is the case, the colon fills completely and the barium mixture can be seen passing into the terminal ileum. These fluoroscopic observations are immediately checked by roentgenograph.

Retan lists the following as evidences of reduction: (1) The colon will fill completely with leakage of barium into the ileum as evidenced under the fluoroscope and confirmed by an *x*-ray photograph. (2) The abdominal tumor will disappear. (3) The child is relieved of all symptoms of shock, pain, vomiting, etc.

Retan and Stephens state that the advantages of attempting to reduce an intussusception under the fluoroscope are that this method is intelligent, scientific, safely conservative, and the diagnosis is definitely established even if the procedure fails. This type of reduction is particularly valuable in the first twelve hours.

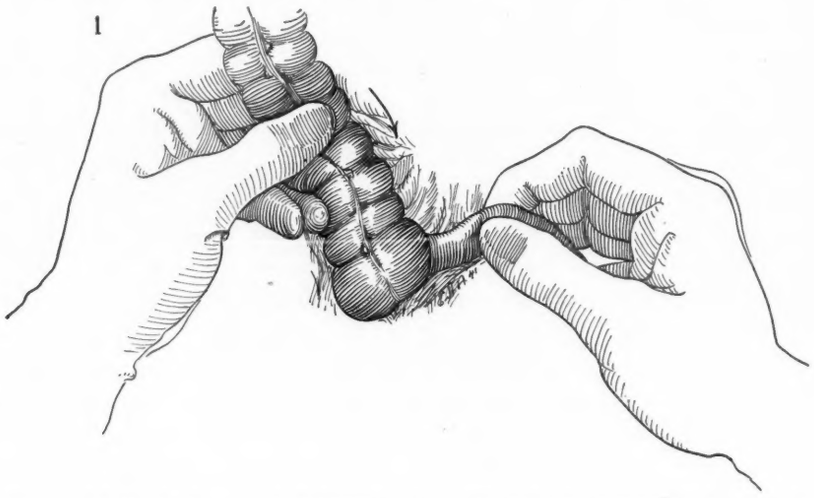

Fig. 1. Method of manual disinvagination. Here the intussuscepted bowel is milked out while gentle taxis is employed on the invaginated portion.

OPERATIVE TREATMENT

The majority of men in this country do surgery from the beginning. Several operative procedures are employed. A right, lower quadrant, rectus retracting incision is the one of choice, although some favor a low midline incision since there is less bleeding encountered and permits access to both right and left portions of the abdomen. In the early cases after the opening of the abdomen and localization of the tumor mass, the milking of the tumor mass is enough, accompanied by warm compresses to reduce swelling. (Fig. 1.) The first part of the reduction is usually easy and may be accomplished by holding the gut firmly with one hand just below the advancing point, and then sliding the thumb and forefinger of the other hand along the sheath, pushing the intussusceptum in front. The last few inches of the reduction are sometimes difficult, and it is here unsafe to put much traction on the gut. The cause of difficulty is usually edema of the gut and mesentery, and perseverance will frequently diminish the edema enough to allow a reduction which at first seemed impossible. At this point it

is wise to note that an appendix delivered from an intussusception is so distended by edema that at first glance it may look as

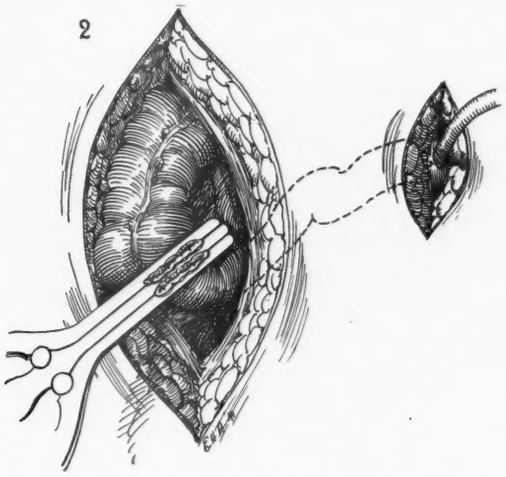

Fig. 2. Obstructive Mikulicz resection of the gangrenous intussusception by a double clamp. Ileostomy performed six inches from resection for purpose of immediate drainage of bowel tract.

though the patient had acute appendicitis. It is very unwise to add an unnecessary appendectomy to a situation already precarious.

When, however, resection becomes absolutely necessary on account of reduction being impossible or because of gangrene, there are many methods to choose from, although they are accompanied by a high mortality rate: (1) Resection with end to anastomosis or an end to a lateral anastomosis; (2) resection with a double enterostomy according to the technic of Mikulicz; (3) lateral anastomosis about the lesion with a secondary resection later if the condition of the child permits; (4) ileostomy with a secondary resection later; (5) lateral anastomosis about the lesion with secondary sloughing and healing. (6) resection of the intussusceptum through an incision in the intussusceptions with or without a lateral anastomosis; and (7) incision in the wall of the intussusceptiens to permit wound reduction, followed by one of the aforementioned methods if necessary.

If exploration reveals an irreducible gangrenous mass, or a nonviable reduced mass, some form of resection must be attempted. In such a case the simplest procedure is to perform a Mikulicz obstructive resection with a temporary ileostomy eight inches from the ileocecal valve through a small stab incision. (Fig. 2.) This immediately relieves the obstruction and enables one to re-establish the bowel continuity by the ileocoloic septum some seven to ten days later.

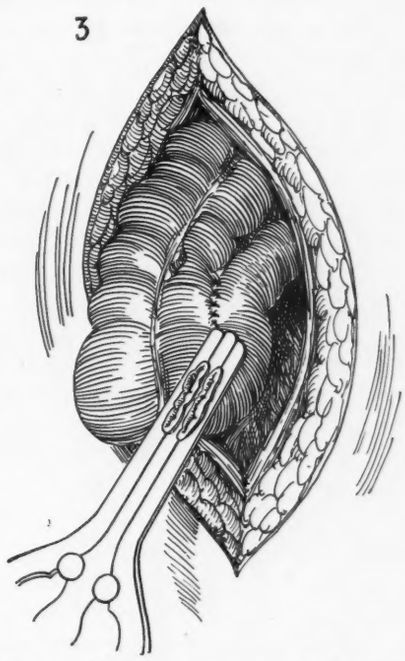

Fig. 3. Mikulicz resection of the gangrenous intussusception with a side-to-side anastomosis between the terminal ileum and proximal colon according to procedure of Barnes Woodhall, who believes that there is less fluid loss with this method.

Woodhall, in 1938, reported several operative cases in which his technic was to do a lateral anastomosis around the lesion followed at the same operation by the usual Mikulicz procedure. (Fig. 3.) He states that in addition to guaranteeing immediate continuity of the bowel lumen, this technical modification has proved distinctly valuable in controlling the resultant intestinal obstruction and fluid loss.

CASE REPORTS

The first two patients were treated by staff surgeons of the Somerville Hospital;

the last three were personal cases of the author.

Case I. No. 40547. S. B., a male infant of seven months, was admitted to the hospital June 15, 1934, with a history of sudden attack of pain with vomiting twenty-four hours before. An enema given by the mother two hours after the first attack showed free blood. The child vomited everything taken by mouth since and had had two free black stools. Examination revealed the baby to be restless as if in pain. The temperature was 101°F. rectally, the pulse was very rapid, ranging from 140 to 160, white blood count 17,000. The abdomen was distended and there was a small mass at the left upper quadrant. Free blood was present on rectal examination and the child was prepared for operation. Clysis of 150 cc. saline was administered.

A left midrectus muscle retracting incision was made. An intussusception, composed of three inches of terminal ileum into ileocecal valve was brought up into the incision and easily reduced manually. The terminal ileum was edematous but not gangrenous. Because of distended loops of bowel, a cecostomy was made. The abdomen was sutured in layers with the cecostomy catheter brought out at the lower end of the incision. A clysis of 200 cc. saline was given postoperatively and the child's condition was good.

On June 16, 1934, the temperature was 104°F. rectally, the abdomen was badly distended and the cecostomy catheter was draining. A small Levin tube was passed intranasally into the stomach and adequate fluids were administered by clysis.

On June 17, 1934, his condition was unimproved. The temperature was 104°F. rectally, pulse, 160, and there was a free movement of bloody mucus. The distention of the abdomen remained the same.

On June 18, 1934, the infant seemed improved; his temperature was 102°F. rectally, and he retained small amounts of liquids by mouth. The abdominal distention was less. At 11:30 P.M. the child developed a high respiratory rate of 64 and expired at 3 A.M. the next morning.

Case II. No. 64780. A. C., a female infant of five months, was admitted to the hospital January 28, 1941, at twelve noon. There had been sudden, acute pain followed by vomiting thirty-four hours before admission. This was followed by a good bowel movement and apparent relief although there were repeated attacks of pain and vomiting. Between attacks the child seemed quite comfortable. There was rectal bleeding noted eight hours before admission. The baby was then seen by a physician who made the diagnosis of intussusception.

Preoperative examination revealed a dehydrated, five-months old baby with knees flexed; temperature, 98.6°F. rectally; pulse, 140; urine negative. Abdominal examination revealed a palpable mass in the right lower quadrant. Rectal examination revealed much free blood. The prognosis was grave in view of the duration from the first attack. It was believed that gangrene was present and the child was prepared immediately for operation. Two hundred cc. 5 per cent glucose in saline were given by hypodermoclysis.

Under ether anesthesia a right rectus, muscle retracting incision was made. The abdomen was opened and revealed a large intussusception of about ten inches of terminal ileum into the ileocecal valve that was reduced manually with great difficulty especially at the last two inches of ileum that were bound down into the cecum. The intussusceptum was black with gangrene extending up into the mesentery. As this portion of the gut was not viable, an aseptic end-to-end anastomosis was made bringing together the ileum and cecum. An ileostomy tube was inserted one foot proximal to the anastomosis. The immediate postoperative condition seemed good. Another clysis of 200 cc. 5 per cent glucose in saline was administered. The condition appeared good until 11 P.M. when the child suddenly developed a high respiratory rate and expired.

Case III. No. 61455. K. P. G., a male, aged four months, was admitted to the Somerville Hospital at 9:30 A.M. on April 25, 1940. The history showed that the child had been perfectly well and healthy since birth but that two days before admission he was seized with a sudden pain followed by vomiting. The mother stated that his bowels moved freely after the acute onset, but that for the past twenty-four hours there had been some blood passed rectally. She also stated that the baby was very "colicky" from the previous day and that there was a gradual distention of the abdomen. The baby vomited all food given since the attack but there was some retention

of water given orally. The child was first seen by a physician on the morning of hospital admittance and immediately transferred for surgical attention.

Physical examination revealed a well developed and well nourished male infant who was listless, but did not seem to be in acute distress. The skin was dry and he was lying on his back with knees flexed. The temperature was 100.8°F. rectally, pulse 132, respirations 30, white blood count, 21,800. Urine was concentrated with slightest possible trace of albumin. The pupils reacted to light; eardrums were normal; the tongue was dry and coated; there was no neck stiffness and no cervical adenopathy. Heart sounds were normal and lungs were clear throughout.

The abdomen was distended but soft. Careful palpation did not reveal a mass. Palpation at the right lower quadrant caused the child to cry; a moderate spasm was felt at this point.

Rectal examination revealed no mass but a good amount of bloody mucus gushed forth on withdrawing the examining finger.

Because of the finding of blood in the rectal examination and noting the history, the infant was operated upon immediately. The operation was performed one hour after admission to the hospital. A clysis of 200 cc. 5 per cent glucose in saline was given into the thighs prior to operation.

Under ether anesthesia, palpation of the abdomen did not reveal a tumor. The abdomen was opened with a right, rectus muscle, retracting incision. On opening the peritoneum the intussusception immediately came into view. The site of intussusception was the ileocecal valve and six inches of ileum were invaginated into the cecum. This was reduced by milking it out manually; the invaginated portion was very dark and much reddened but not actually necrotic. The ileum was fixed to the cecum by two gastro-enteric sutures to prevent recurrence. The abdomen was closed without drainage, and the immediate postoperative condition was good.

The child was returned to the ward and kept warm. Another clysis of 200 cc. 5 per cent glucose in saline was given into the thighs postoperatively. Another clysis of 100 cc. was given at 3:30 P.M. and at 8:00 P.M. The infant was quieted by the administration of ten drops of paregoric orally every three hours. He began to retain water by mouth in two and three ounce amounts eight hours after operation and a milk formula the next day. Convalescence was smooth, except for an elevation of temperature to 103°F. rectally on the second day, which subsided by lysis by the fifth day. A stitch abscess was opened on the seventh day. He was discharged with the incision well healed on the ninth day.

Case IV. No. 64431. M. De B., a male, aged six months, was admitted to the Somerville Hospital on December 28, 1940. The baby was well until 5 P.M. on the day of the admission, when he was seized with acute pain followed early by vomiting which was persistent. He was seen at home at 8 P.M.

Physical examination revealed a well developed and well nourished male infant, lying on his back with knees flexed, crying vigorously during paroxysms, but entirely quiet for three to five minutes between paroxysms. The temperature was 98°F. rectally, pulse, 110, respirations 28; skin moist, white blood count, 9800.

The routine examination was negative except for tenderness and moderate spasm at the right lower quadrant. The abdomen was otherwise soft with no distention. No tumor was felt. Rectal examination revealed a bloody discharge on withdrawal of the examining finger. Because of this latter finding a diagnosis of acute intussusception was made and the child was taken to the Somerville Hospital for operation. The infant was prepared preoperatively by administration of a clysis of 200 cc. 5 per cent glucose in saline into the thighs.

Under ether anesthesia a right, rectus muscle, retracting incision was done. On opening the peritoneum there immediately came into view a large sausage-like mass with bluish discoloration; this mass composed the terminal ileum, appendix and cecum invaginated into the ascending colon for a distance of three inches. This intussusception was milked out manually and revealed the intussusceptum to be very edematous and discolored but not necrotic. The abdomen was sutured in layers. The immediate postoperative condition was good. A clysis of 100 cc. of 5 per cent glucose in saline was given into the thigs postoperatively. After ether recovery the child maintained fluid given by mouth. His regular milk formula was given on the following day. The convalescence was smooth and the child was discharged on the eighth day with a well healed incision.

Case v. No. 65126, A. Le B., a male, aged six months, was admitted to the Somerville Hospital on March 1, 1941. The mother stated that the child had a bowel movement that was streaked with blood twenty-four hours previous to admission. She further stated that she afterward gave the child some milk of magnesia and when no further bowel movement occurred she placed a finger in the baby's rectum which showed some blood. The child had vomited two of his feedings. At no time previous to his hospital admittance did he seem to have any abdominal pain.

Physical examination demonstrated a very well developed and well nourished child, lying on his back with legs extended, temperature was 99.6°F. rectally, pulse 120, respirations 32, white blood count 7,750; urine examination was negative. Ears, eyes, nose, throat, heart and lungs were negative.

The abdominal examination revealed no distention but showed some tenderness through the whole lower portion of the abdomen on palpation. Rectal examination showed a small amount of old blood on the examining finger.

Although this child did not have typical symptoms of intussusception as far as acute onset, pain and vomiting were concerned, it was believed that there was a possibility of this condition and that a barium enema *x*-ray would demonstrate whether or not there was any obstruction along the large bowel tract. The barium enema revealed a complete filling of the large colon, no incompetency of the ileocecal valve and a filling of the terminal ileum. (Fig. 4.) In view of this the possible diagnosis of intussusception was dismissed. The child did well during the hospital stay except for a slight elevation of temperature the fifth and sixth days due to an upper respiratory infection. The child was discharged on the ninth day as well. Diagnosis: Enterocolitis.

Fig. 4. *X*-ray proving the absence of intussusception. The large bowel fills completely with the barium enema. There is no deformity of the cecum, and no incompetency of the ileocecal valve.

SUMMARY

1. Acute intussusception is the most common cause of obstruction in infancy.

2. History of acute intussusception is classical: Sudden acute pain in a healthy infant; early symptoms of shock with its

pallor, rapid pulse, sweaty skin, vomiting; abdominal mass; the finding of blood in the rectal examination is practically a criterion of this condition. Diagnosis can be further substantiated by *x*-rays in which the barium enema shows blockage along the bowel tract in the case of intussusception.

3. Early operation is advised since, if done early, the operation will consist merely of a manual disinvagination and carries a small risk. Operation done in cases after thirty-six to forty-eight hours are prone to require some form of resection with its attendant high mortality. These forms of resection are listed.

4. Palpation of an abdominal mass in acute intussusception is a late sign and should be considered in prognosis more than in the diagnosis.

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MANAGEMENT OF THE BURNED PATIENT*

DONALD C. GEIST, M.D.
Diplomate of the American Board of Surgery
PHILADELPHIA, PENNSYLVANIA

THE management of the burned patient constitutes an important surgical problem. Vital statistics reveal that there has been little reduction in the mortality in the United States from the year 1930 to 1938 inclusive. During the year 1939 a significant decrease in mortality did occur. Whether this reflects the effects of the renewed interest in the burn problem in the past few years is difficult to decide. McClure has called attention to these facts and has stressed the necessity for both the prevention of these injuries and their more thorough treatment. Cohen, in an article on the management of burns in the present war, has suggested the necessity for a "prepared routine of treatment" a thought which may be useful in civilian surgery.

An experience with the management of seventy burned patients in a general hospital leads to the belief that much emphasis must be placed on the treatment of the patient as a whole rather than stressing either the local or systemic manifestations. These cases can be divided into two equal groups, one being treated by the tannic acid method and the other by a variety of methods. Such a series is too small for detailed statistical deductions but certain facts stand out as deserving emphasis. (Table 1.) Seventeen or 24.2 per cent of these patients died and of these deaths 50 per cent had one-half or more of their body surface burned. The majority of the patients who died (76.5 per cent) were under ten or over sixty years of age. Seventy and five-tenth per cent of the cases had 25 per cent or more of body surface burned. The majority of the deaths (94.1 per cent) occurred within the first seventy-two hours, only one death coming after that period. This fact held true regardless of the method of treatment employed, an observation noted by McClure, Glover and others. The mortality was greater in the tannic acid series (28.5 per cent) than in the other (20 per cent). However, in this group, there were twice the number of individuals with 50 per cent or more of their body surface burned, a great number at the extremes of age and a greater number of cases of initial shock. Hence, no great significance should be attributed to this difference in mortality. The incidence of infection was definitely lower in the tannic acid group, 14.2 per cent as compared to 25.7 per cent in the group treated otherwise.

TABLE 1
STATISTICAL INFORMATION IN SEVENTY PATIENTS TREATED FOR BURNS

Total number of patients	70
	Per Cent
Total mortality	17–24.2
Mortality in tannic acid series	10–28.5
Mortality in pretannic acid series	7–20
Infection in tannic acid series	5–14.2
Infection in pretannic acid series	9–25.7
Percentage of deaths within twenty-four hours	10–58.8
Percentage of deaths within forty-eight hours	13–76.4
Percentage of deaths within seventy-two hours	16–94.1

A brief discussion of the various theories concerning the cause of death and altered physiology in the burned is necessary for the proper understanding of their care. In 1925, Davidson described the tannic acid method of treatment. He believed that the toxemic theory offered the best explanation of the sequence of events in this injury and that the production of a coagulum by the local application of tannic acid solutions prevented the absorption of toxic substances of some type from the burned tissues. Modifications of the method have been advocated since his work and of these

* From the Surgical Service of Dr. J. A. Kelly, Misericordia Hospital, Philadelphia, Pennsylvania.

the combination of tannic acid and silver nitrate as described by Bettman seems to offer improvement. Bettman believes that the almost immediate formation of a soft pliable eschar resulting from this combination has decided advantages over the slower method of tannic acid spray. Others have added antiseptics such as gentian violet, acriflavine or methyl violet to the tannic acid solution. Murless and Cohen have recently described their use in the treatment of burns occurring in the present war.

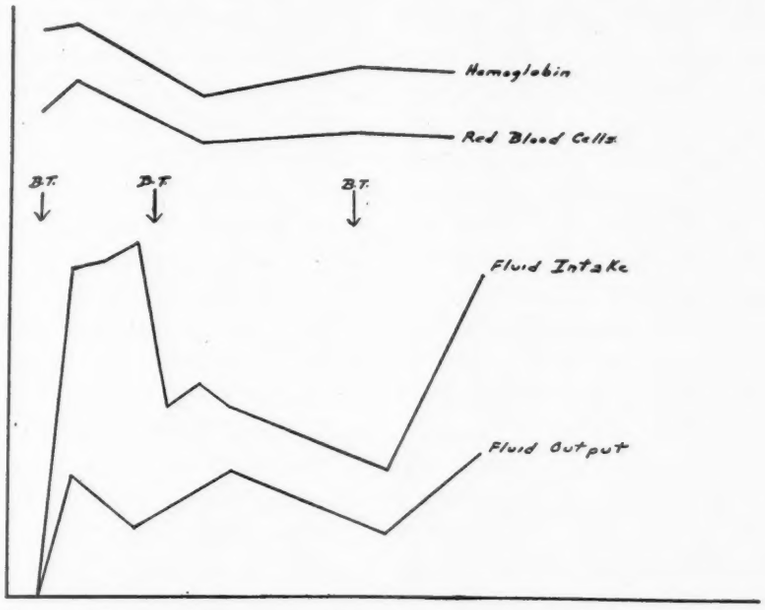

Fig. 1. Graph showing correction of hemoconcentration in a severely burned patient. Initial hemoglobin was 105 per cent and initial red cell count 5,350,000. B.T. signifies blood transfusion.

Underhill, Kapsinow, Fisk and Merle, in 1923, studied a series of twenty-one severely burned patients and found definite and marked evidence of concentration of the blood in the burned person. This hemoconcentration could readily be demonstrated by repeated hemoglobin determinations. The degree was proportionate to the extent and severity of the burn. They also showed that by forcing intake hemoconcentration disappeared and the patient improved. They believed that an increase of 40 per cent of the normal, if maintained for a considerable time, was incompatible with life. In 1930, Underhill and co-workers found in experiments on burned rabbits that hemoconcentration was caused by an increased capillary permeability with the escape of fluid into the subcutaneous tissues. They believed that the flow was in only one direction and that the fluid loss from the blood could reach as much as 70 per cent of the blood volume. Additional experiments led these observers to the opinion that this loss was plasma and that the edema fluid had a higher percentage of nonprotein nitrogen, potassium, manganese and inorganic phosphorus. They found, too, that the blood chlorides were decreased only in those cases which had extreme degrees of hemoconcentration. McIver, Black, Elkington and many others have demonstrated the presence of such homoconcentration.

It remained for Aldrich to propose another explanation. Aldrich cultured a group of burned patients from the onset of the injury through a large part of their course. He found that during the first twelve hours the burns were sterile but that after that time he was able to culture beta hemolytic and gamma streptococci in 100 per cent of the cases. Moreover, after forty-eight to fifty-six hours pure cultures of

these organisms could be secured. He believed, therefore, that such infection was the cause of these events. Aldrich then advocated the treatment of the burned with a 1 per cent aqueous solution of gentian violet as a spray until an eschar was produced. By the use of such therapy excellent results have deen reported. Although there is no question as to the part played by infection late in the course of burns, it seems difficult to explain the early deaths by such a mechanism.

Further investigation of the hemoconcentration and fluid exchange in the burned patient shows that because of the increased capillary permeability and stasis there is a loss of plasma proteins with a decrease in plasma volume and total blood volume. Elkington, Russell, Wolff and Lee have demonstrated these changes and believe that the protein loss may be replaced by plasma transfusion with improvement of the patient. They call attention to the fact that the abnormal permeability persists for thirty-eight to forty hours and after this time the condition may be corrected by one large plasma transfusion. These workers have evolved a formula for the determination of the amount of plasma needed. Lucido, McClure, Black, Trusler and many others have called attention to the loss of plasma protein and the benefits of plasma or blood transfusions. According to many observers the simple forcing of fluids may not be sufficient to correct the hemoconcentration and may, by alteration in electrolytes, cause harm. Trusler has called attention to the similarity between such a situation and water intoxication. Many have stressed the necessity for plasma rather than blood transfusions claiming that whole blood may be injurious in the presence of marked degrees of hemoconcentration. We have no experience with plasma transfusion in the burned but are convinced that whole blood has saved many patients and has apparently not been harmful.

Evidence of liver damage in burned patients has been demonstrated by decreased values in liver function tests and in the postmortem changes found in the liver of those dying. Wolff, Elkington, Russell and Rhoades have investigated liver function tests in such patients and found definite evidence of lowered function by the bromsulphalein and hippuric acid liver function tests and prothrombinemia. In addition changes in the bilirubin and dextrose tolerance were suggestive of lowered hepatic function. Belt reported the autopsy findings in four patients dying of severe burns. He described two types of change in the liver: marked areas of midzonal necrosis and fatty degeneration throughout the liver. McClure states that degrees of liver necrosis thought to be incompatible with life were found in four of five such autopsies. Wilson, Macgregor and Stewart called attention also to the midzonal necrosis and fatty degeneration in their patients dying of acute toxemia of burns. Whether these findings are the result of a specific toxin, infection or anoxia is unknown.

The theory of a specific burn toxin is being revived. Wilson, Roxburgh and Stewart suggest such a toxin as the result of experiments in which they injected into rabbits the edema fluid from burned tissues. They were able to secure toxic effects either by subcutaneous, intravenous or intraperitoneal injection. When these animals were autopsied, the liver changes mentioned above were found.

Many of the changes described in the foregoing have been found in our patients. Sufficient studies were done on eight of these patients to show that a moderate or severe degree of hemoconcentration is often seen. The accompanying graph (Fig. 1) shows such change with its correction on the forcing of fluids and use of blood transfusion. Blood chlorides were determined on a group of these people and the values are listed in the accompanying table. (Table II.) They were decreased in two instances in one of which the patient died before a further check could be made. It is not known, therefore, as to whether the change

was significant. In the other the decrease was correct and disappeared on intravenous therapy. Serum proteins were done in three of these patients and showed a slight reduction of total protein in all of these. It was not marked. A shift of the albumin-globulin ratio with return to normal after blood transfusion occurred in one of these. The actual figures are given in Table III. Liver function tests have been done in one recent instance. This patient showed a definitely lowered hippuric acid liver function test and a dextrose tolerance curve suggesting lowered hepatic function.

Table II
BLOOD CHLORIDES IN TEN BURNED PATIENTS

Patient	Adm. Date	Date of Test	Blood Chlorides	Per Cent of Body Surface Burned
D. R.	11/23/34	11/23/34	420	10
R. C.	2/16/36	2/17/36	430	25
W. R.	10/24/36	10/25/36	480	5
L. D.	11/16/36	11/17/36	464	50
		11/24/36	500	
S. B.	12/15/37	12/16/37	500	20
C. H.	12/16/37	12/17/37	460	10
M. F.	5/6/38	5/7/38	460	5
C. R.	10/23/39	10/24/39	428	55
		10/27/39	500	
		2/26/40	420	
		3/4/40	440	
		3/12/40	460	
F. R.	5/3/40	5/3/40	360	80
J. N.	11/17/40	11/18/40	340	15

Average normal for laboratory—450–500 mg. per 100 cc.
Patient F. R. died before repetition was possible.
Patient J. N. corrected by intravenous salt solution.

GENERAL OR SYSTEMIC TREATMENT

The first consideration is concerned with the care of shock. Adequate use of morphine or other sedatives to control pain is necessary. External heat must be used to restore body temperature. Fluid balance must be corrected and especial attention paid to adequate amounts of water, chlorides and proteins. The fluid intake of water must be sufficient, in some instances 4,000 to 6,000 cc. being necessary in every twenty-four hours. Bettman says 1,000 cc. of fluids should be given every twenty-four hours for every twenty-five pounds of body weight. Chlorides are best given by intravenous salt solution and proteins supplied by repeated plasma or blood transfusions, frequently in large amounts. In the series of burns reported here we have used blood transfusion in large amounts in the first few days especially. The importance of such treatment especially in the first seventy-two hours after injury is attested to by the high mortality during this period. Reduction in mortality may be possible by more attention to this interval of time.

Chemotherapy has been suggested as a part of the treatment of burns. Cohen, in a report on a series of burns treated in the present war, stated that all were given sulfanilamide for the first five to six days because of the danger of infection. Wilson, Macgregor and Stewart believe that chemotherapy is a help although they state that the number of cases in which they used it was not great. Penberthy and Weller used sulfapyridine in six cases in their series, one of whom had a bronchopneumonia and two a septicemia. They advocate its use, especially in those who develop a complicating pneumonia. We have used sulfanilamide in two patients to hasten the decrease of infection and it improved each of these patients. Sulfapyridine was used in one of these but had no effect.

LOCAL TREATMENT

The tannic acid method or some modification such as the tannic acid-silver nitrate method has been most useful in local care. Glover, McClure, Penberthy, Mason, Beekman and many others have testified to the decrease in mortality since Davidson's introduction of this method. Almost all have agreed to the greater ease of use, shorter hospitalization and lessened pain achieved by it. In addition there is less scarring and decreased necessity for skin graft and other reconstructive measures. This has been true of the series reported here. In addition these cases strongly

support the lessened infection as mentioned earlier in the paper.

The technic for this procedure has been described many times. McClure and others have stressed the necessity for strict asepsis. The same technic must be used in the dressing of the burns at their various stages. This means, of course, the use of sterile supplies, gloves, caps and masks. Following the careful cleansing, under anesthesia if necessary, the burned areas may be treated with tannic acid or one of its combinations. If the patient is admitted in shock, the procedure must wait the correction of it. When the eschar becomes loose it must be removed and the wound carefully débrided. The management of the granulating wound after removal of the eschar is a matter of preference. Our own group has been cared for with sterile vaseline gauze and dry dressings with the addition of 1 per cent gentian violet to infected areas. Glover and his associates have advocated early removal of the crusts and continuous use of Dakin's solution dressings to the granulating areas. Dakin's solution was used in some of the earlier cases of this series when they became infected and quickly relieved the infection. A great many of the early cases in this group were treated by a variety of local applications of ointments, solutions and wet dressings. In reviewing them in comparison with the tannic acid group there is no doubt of the efficacy of the latter method. Frequent débridement of burned areas and the early use of skin grafting are very helpful.

TABLE III
SERUM PROTEIN IN THREE BURNED PATIENTS

Patient	Total Protein	Serum Albumin	Serum Globulin	Per Cent of Body Surface Burned
C. R.	5.7	3.6	2.1	55
	5	3	2	
	5.7	3.1	2.6	
	4.7	3.5	1.2	
	4.1	2.5	1.6	
	5.9	3.6	2.3	
	(Last three values above found late in course of burn from large granulating surface, vomiting and refusal to eat. Correction by blood transfusion—high protein diet—vitamin B complex)			
J. N.	6	1	5	15
	5.7	3.1	2.6	
	6.3	4.3	2	
F. R.	5.7	4.1	1.6	80

Average normal for laboratory given as 6–7 mg. per 100 cc.

LABORATORY INVESTIGATION

Routine laboratory studies aid in the management of burns. Daily urinalysis, frequent determination of hemoglobin, red cell count and hematocrit are necessities. Regular determinations of plasma proteins should be made especially in the early period. Blood urea nitrogen and nonprotein nitrogen values are an aid. Blood chlorides should be determined if indicated. Some type of liver function test should be done. Frequent leucocyte counts and cultures of the burned areas are necessary. Other determinations are done as indications arise. The frequency of such investigation depends upon the patient's progress.

CONCLUSIONS

A review of a small series of burned patients treated in a moderately sized general hospital is given. The various theories concerning burns and their treatment are briefly summarized. The necessity for some planned routine of treatment which considers the burned patient as a complete therapeutic problem is suggested and the essential elements of such a plan are outlined. The stressing of these facts should aid in the treatment of such patients in general hospitals to which most of them are admitted.

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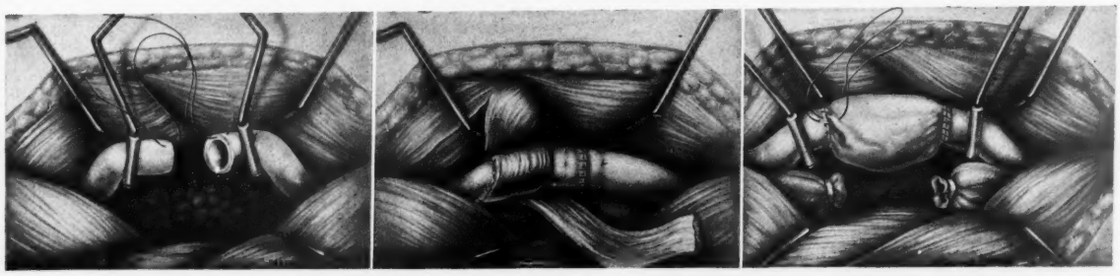
ARGYRIA is characterized by a bluish- or slate-gray hue of the skin, due to deposits of silver salts in the tissues. In rheumatoid arthritis, patchy or diffuse areas of increased pigmentation not infrequently appear on the extremities or, less often, the face.

THE TREATMENT OF TRAUMATIC AND WAR WOUNDS OF THE VASCULAR SYSTEM*

GERALD H. PRATT, M.D.
Assistant Clinical Professor of Surgery, Post-Graduate Medical School, Columbia University
NEW YORK, NEW YORK

EXPERIENCE in a large vascular clinic with an attendance of approximately 120 patients a week has demonstrated how neglected has been the teaching in the management of the vascular problems and diseases. With our participation in a major and serious war, this knowledge of vascular problems becomes a necessity for the military surgeon. The decision as to amputation must be made by the operating surgeon and this decision may affect not only the limb but the life of the individual as well. Belated efforts to give this special training to the men called into the service necessarily will fail. Certain fundamental, underlying principles may be helpful.



A B C

FIG. 1. A, end-to-end arterial suture; fine silk; needle does not enter intima. Elevation of artery from its bed and flexion of joint allows approximation. B, re-enforcement of suture line with nearby muscle or fascia. C, section of vein used to replace destroyed artery. When clamps are removed, vein wall shrinks to size of arterial blood column.

While the tourniquet may be life saving, its incorrect application may prevent restoration of the circulation. The tourniquet, when used, should be applied as close to the wound as feasible; and where extra pressure is required for hemorrhage control, this should be a well padded object applied directly over the vessel just proximal to the laceration site. In many instances the application of a clamp to the bleeding vessel is adequate and more satisfactory. While it seems unnecessary to stress the point, patients still bleed to death, even with medical attendance. Digital pressure is sufficient to stop hemorrhage and in relays it has been used over several days time. When a tourniquet has been applied, the operation should be performed at the nearest available hospital. Circulation has been restored, however, in closed vessels even after forty-eight hours.

OPERATION

The surgeon must be taught that amputation, while sometimes necessary, should be performed as a last resort. Mere laceration of a major artery is not an indication for amputation. With the severance of an artery, an end-to-end arterial suture can be accomplished in many instances. The suture material should be fine and the needles minute. The needle should not enter the intima. Inasmuch as the pressure on the arterial wall at any point is inversely proportional to the rate of flow, very few sutures will be necessary. A muscle or fascial layer can be used to reinforce the

* From the Surgical Vascular Clinic, New York Post-Graduate Hospital and Medical School, Columbia University.

suture line. (Fig. 1A and B.) When a section of artery has been lost, the defect up to 5 cm. can be closed by lifting the vessel from its bed and flexing the limb. Venous transplants (Fig. 1C) to carry the arterial circulation have been successful in many instances. With the availability of heparin and dicoumarin* this plastic arterial surgery has been modernized and is now routine in a vascular surgeon's practice.

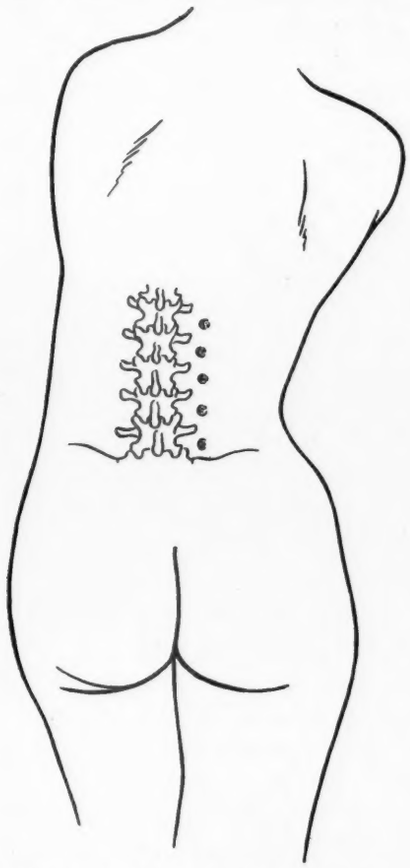


Fig. 2. Position of patient for perivertebral nerve block. Dots placed 4 cm. lateral and between the spines. Twelfth dorsal, first, second, third and fourth lumbar outlined.

Arterial thrombi, present in 50 per cent of injuries to arteries, should be removed prior to suturing. These can be lifted out with a forceps or the use of a silver wire corkscrew, as in the removal of emboli.

* Wright, I. S. The use of (dicoumarin) 3-3′ methylenebis-4 hydroxycoumarin in man—preliminary observation. (In press. *Bulletin, N.Y. Academy of Medicine.*)

When arterial ligation is necessary or has already been performed, the loss of the limb does not necessarily follow. The femoral artery may be ligated in 18 per cent without gangrene and this may be decreased to approximately 8 per cent by ligating the accompanying vein. The ability of the collateral circulation to take over the nutrition of a limb after the closure of a major vessel is stupendous, especially when stimulated.* The physiological action of these collateral vessels, following a major vessel insult, is to go into spasm. This spasm probably prevents the development of thromboses. After the major vessel has been repaired or ligated, efforts to dilate and expand the collateral circulation should be taken. These are:

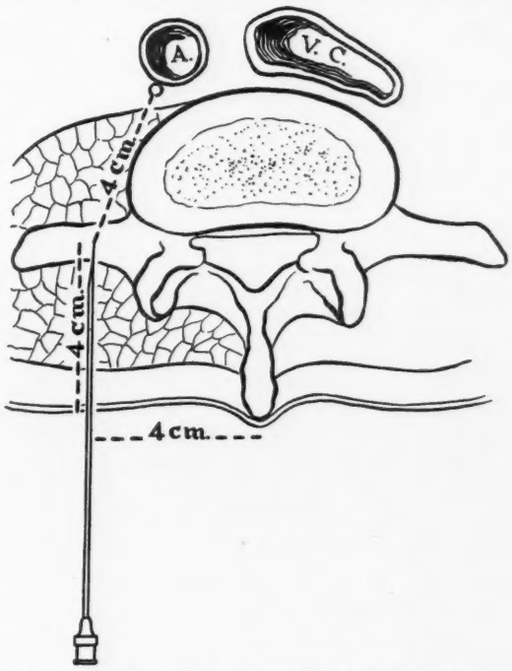


Fig. 3. Perivertebral nerve block lumbar area. The needle is introduced 4 cm. lateral to the intraspinous space, thus missing the transverse process. After introducing the needle 4 cm., its direction is slightly varied medially and advanced 4 cm. more. Careful aspiration eliminates intradural or intravenous injection.

1. *External Heat.* This must be graded and is best maintained between 88° and 96°.

* Wright, I. S. Conservative treatment of occlusive vascular disease. *New England J. Med.*, November, 1941.

2. *Postural Changes.* Elevating the leg, leveling the leg and lowering the leg constitutes a mild vascular massage. With the oscillating bed this may be made continuous.

3. *Abstinence from Tobacco.* This is most important, as it seems routine to "stick a cigarette in a wounded soldier's mouth," whether he can breath or not. It has been proved without question that nicotine will cause small arterial vessels to go into spasm and if these small vessels are all that are carrying the patient's circulation, circulatory failure to the periphery will result. This cannot be overemphasized.

4. There are *certain drugs* which help reduce spasm and dilate collateral vessels. One of the best and most acceptable from the patient's standpoint, is alcohol in the form of whiskey. Deproteinated pancreatic tissue extract, an adrenalin neutralizing product, also aids in reducing vessel spasm. Such smooth muscle dilators as pantopon, papaverine and atropin, likewise may play a part.

5. The *part the sympathetic system plays* in the spasm of major and collateral vessels is now well understood. A perivertebral sympathetic nerve block, using novocaine, gives temporary sympathectomy effect and is most helpful in re-establishing circulation. The armamentarium is uncomplicated, the technic is simple and with training, any qualified surgeon can perform it safely. This should be a routine procedure in any major vessel injury. (Figs. 2 and 3.)

In some amputations, the refrigeration technic will have its place. Ice usually is available in all hospitals. The technic, as we have followed it, is to pack the limb to be amputated in ice to the groin. Thirty minutes after this packing, a tourniquet is applied and the limb replaced in the ice. One and a half to two hours thereafter amputation can be performed painlessly and without shock. If the amputation is in the thigh, the sciatic nerve should be anesthetized with local anesthesia prior to its division.

While amputation technic is beyond the scope of this paper, it might be emphasized that morbidity and mortality can be minimized if certain points are followed: (1) Thoroughly cleanse the area to be amputated; (2) do not make muscle or fascial flaps; (3) close the wound with two or three sutures only; in doubtful cases, leave open; (4) immobilize the amputation stump and protect it from soiling; do not dress it for two weeks unless systemic reaction requires it; (5) use prophylactic gas gangrene, tetanus serum and sulfa drugs.

Discussion of the sulfa group of drugs has not been included in this paper because of the many articles already describing their use.

SUMMARY

Surgeons in general have not been trained in the management and treatment of the lesions involving the vascular system.

Knowledge of these lesions will become increasingly important with our participation in a major war.

It is not necessary to amputate when a major vessel has been severed.

Arteries may be repaired by suturing or venous transplants.

Many methods of stimulating collateral circulation are available.

Perivertebral sympathetic nerve block has proved helpful.

In neglected or advanced gangrene requiring amputation, the refrigeration technic reduces the mortality.

LARGE BONE METASTASES FROM CARCINOMA OF THE BLADDER*

CHARLES C. HERGER, M.D.
Diplomate of the American Board of Urology;
Attending Urologist, New York State Institute
for the Study of Malignant Diseases

AND

HANS R. SAUER, M.D.
Assistant Urologist, New York State Institute
for the Study of Malignant Diseases

BUFFALO, NEW YORK

METASTASES from carcinoma of the bladder to the regional lymph-nodes and visceral organs are common especially in the late stages of the disease. Their incidence is placed by various authors at from 8 per cent (Bladder Tumor Registry of the American Urological Association) to 56 per cent (Leadbetter and Colston) of the cases with vesical cancer.

In many instances it is difficult for the clinician to demonstrate the presence of metastases, because the clinical manifestations often do not point to the organ or organs involved. Besides, these manifestations are frequently overshadowed by the severity of the symptoms produced by the primary lesion. Metastatic involvement of retroperitoneal lymph-nodes, liver, spleen and kidneys may be frequently suspected by the urologist, but an exact diagnosis can be made only if the size of the metastases permits their palpation, or if secondary clinical signs and symptoms develop. On the other hand it is fairly easy to demonstrate roentgenologically metastatic foci in the lungs or in the skeleton, while involvement of the superficial lymph-nodes can be diagnosed readily by palpation and biopsy.

It is obvious, therefore, that reliable data as to the incidence of metastatic lesions from carcinoma of the bladder can be obtained only from autopsy material. This statement is illustrated best by comparing statistics based on clinical observation with those based on postmortem examination. For instance, Judd reported that but twenty-one or 12.6 per cent of 166 patients, who died of the disease, were known to have had metastases, while Leadbetter and Colston found metastases in fifty-five or 56.1 per cent of the cases in an analysis of ninety-eight autopsy cases. In the study of their material Leadbetter and Colston came to the conclusion that in fifty-one of their fifty-five patients death occurred from uremia and infection and not from general carcinosis.

Reports by various authors agree that metastatic involvement of the skeleton is common in all cases in which widespread metastases are encountered. However, cases with such large bony metastases that they dominate the clinical picture, are comparatively rare and they receive little or no attention in the various textbooks in urology or pathology. For instance, no case of carcinoma of the bladder producing bone metastases was found by Moore in a report based on sixty-five cases of metastatic bone lesions. In a study of 334 cases of skeletal metastases Geschickter and Copeland found but one case in whom the primary tumor originated in the bladder. Of 1,032 patients with metastatic bone lesions, collected by Sutherland, only nine were from bladder tumors. Only Graves and Militzer suggest that metastatic lesions to the skeleton occur more frequently than generally supposed. They found evidence of metastatic bone lesions in five patients or 11.6 per cent of forty-three consecutive cases of bladder carcinoma. It appears probable, however, that the figures presented by these authors are accidentally

* From the State Institute for the Study of Malignant Diseases, Buffalo, New York, Burton T. Simpson, M.D., Director.

high, since the total number of forty-three cases is too small to permit conclusions as to the incidence of bone metastases from bladder tumors. Statistics based on larger clinical material point to a less frequent occurrence. Herbst found an incidence of 2.2 per cent (139 clinical cases), Judd of 3.0 per cent (166 autopsy cases) and the Tumor Registry of the American Urological Association reported metastatic bone lesions in 3.7 per cent of 902 cases studied.

A B

Fig. 1. Case 1. A, osteolytic bone lesion from solid infiltrating carcinoma of the bladder; B, ten months later; further progression of lesion and pathological fracture of tibia.

Bone metastases from carcinoma of the bladder are usually of the osteolytic type and only a few isolated reports (Kretschmer, Graves and Militzer and Livingston) indicate that attempts at new bone formation might occur in some instances. Once metastases to the bone have developed, they grow rapidly and may attain considerable size. For instance, in the case reported by Wells, a secondary tumor of 1640 Gm. was found at autopsy in the sternum.

Reports in the literature indicate that there exists no relationship between extensiveness of the primary lesion and tendency to formation of secondary bone lesions (Herbst). Case reports by Kretschmer, Burkland and Leadbetter give evidence that comparatively small primary carcinomas without much evidence of infiltration may be responsible for the development of extensive bone metastases. In some of the patients reported by Burkland and Leadbetter the primary tumor was thought to have been controlled or even eradicated.

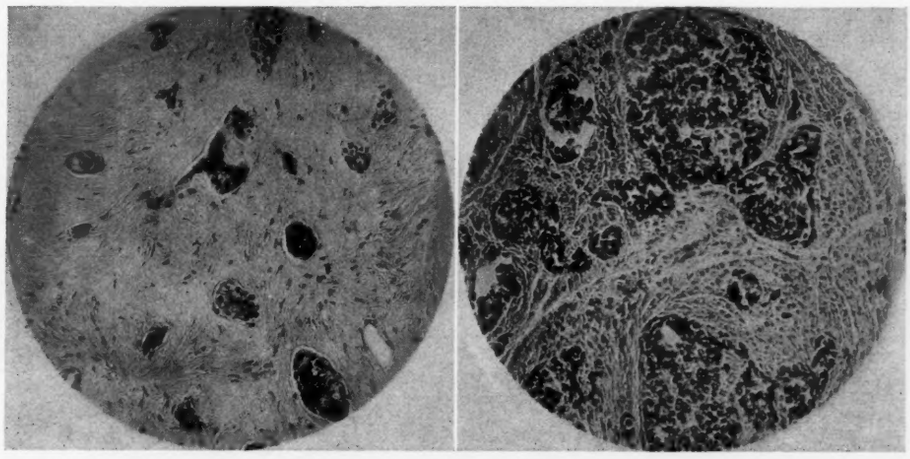
The part of the skeleton most frequently involved by metastases is the pelvic girdle (Graves and Militzer). Of twenty-three cases with metastatic bone lesions which we collected from the literature,* the secondary tumor was found in the pelvic bones in seventeen instances. Aside from the pelvic girdle there seems to be no particular predilection for any bone.

It has been the experience of various authors (Lowsley and Kirwin, Smith and Mintz, Herbst, etc.) that generalized carcinosis including multiple small-size foci to the bones is encountered more frequently in the group of solid infiltrating tumors of the bladder. However, it appears from reports in the literature that the large metastatic lesions to the skeleton are seen more frequently in tumors of the papillary type. Of the twenty-three patients already referred to before, sixteen had papillary cancers, the remaining seven had solid infiltrating carcinomas. The histological appearance of the tumor in the sixteen patients with papillary carcinomas was of comparatively low grade malignancy in some of the cases.

Large metastatic bone lesions were demonstrated in only four cases of 597 pa-

* Burkland and Leadbetter, Graves and Militzer, Greenfield, Jonkinson, Livingston, Wells, Zeman.

tients with carcinoma of the bladder observed at the New York State Institute for the Study of Malignant Diseases during the past twelve years. It appears questionable, however, whether these four patients represent the total number of such lesions because many of our patients were not seen in their terminal stages, or were lost trace of shortly after admission.



A B

Fig. 2. Case I. A, biopsy from bone lesion showing squamous cell carcinoma; B, biopsy from bladder tumor showing solid infiltrating squamous cell carcinoma invading bladder wall.

CASE REPORTS

Case I. F. A., No. 11930, sixty-eight years old, a white, male, was admitted to the hospital May 12, 1929. The patient gave a history of gradually increasing pain and lameness of his left leg beginning four months prior to admission. Examination of the left leg revealed swelling and tenderness over the middle third of the tibia extending over an area of 6 cm. in length. Otherwise the physical examination was essentially negative. The urine contained a trace of albumen and occasional white and red blood cells. The blood Wassermann was positive.

The *x*-ray picture of the left leg revealed osteolytic changes in the middle third of the tibia involving chiefly the cortex and the periosteum. (Fig. 1A.) Since a syphilitic lesion was suspected, antiluetic treatment was started which did not influence the condition. A biopsy from the lesion, made on July 6, 1929, proved it to be metastatic carcinoma. (Fig. 2A.) The tumor cells were partly squamous and partly anaplastic and extensive destruction of the bone structure was present.

Search for the primary lesion started with examination of the gastrointestinal tract which yielded negative results. Although the patient had no symptoms referrable to the genitourinary tract, cystoscopic examination was

Fig. 3. Case II. Extensive bone destruction from papillary carcinoma of the bladder involving upper third of femur, acetabulum and inferior ramus of ischium.

then performed which revealed a large, solid, infiltrating carcinoma originating in the left side of the trigone extending half way to the left lateral wall and to the vesical sphincter. Biopsy from the tumor of the bladder showed the same histology as the biopsy of the tumor obtained from the lesion in the left tibia. (Fig. 2B.) The tumor was a solid carcinoma of the squamous cell type with evidence of extensive invasion into the deeper layers of the bladder wall.

X-radiation over primary and secondary tumor as well as radon seed implantation into the bladder tumor had little influence on either. Repeated *x*-ray pictures of the left tibia revealed rapid progression of the bone destruction. An *x*-ray plate made on March 7, 1930, showed a pathologic fracture in the middle third of the tibia with extensive destruction of the shaft extending almost to the articular surface of the knee joint. (Fig. 1B.)

The patient died on May 28, 1930. An autopsy was performed and aside from the secondary tumor in the tibia, metastatic lesions of from 0.5 to 3.5 cm. in diameter were found distributed throughout both lungs.

The unusual feature of this case is the absence of signs and symptoms pointing to the presence of a fairly large primary carcinoma of the bladder although an extensive secondary tumor developed in the tibia. We believe that the secondary tumor growth in the tibia was embolic in origin, inasmuch as the autopsy findings revealed extensive multiple metastases distributed throughout both lungs.

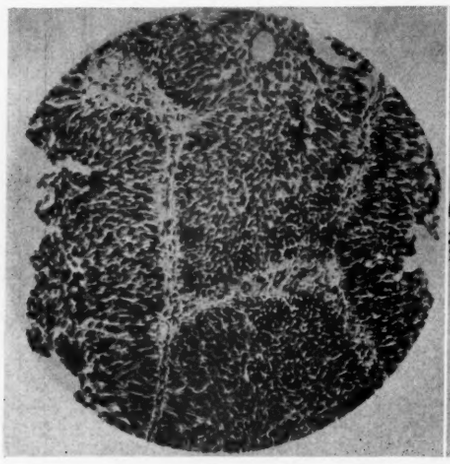


FIG. 4. Case II. Biopsy from bladder tumor showing papillary carcinoma composed of regularly arranged, well differentiated squamous cells.

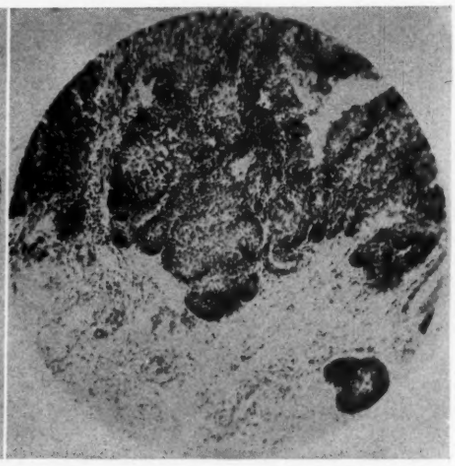


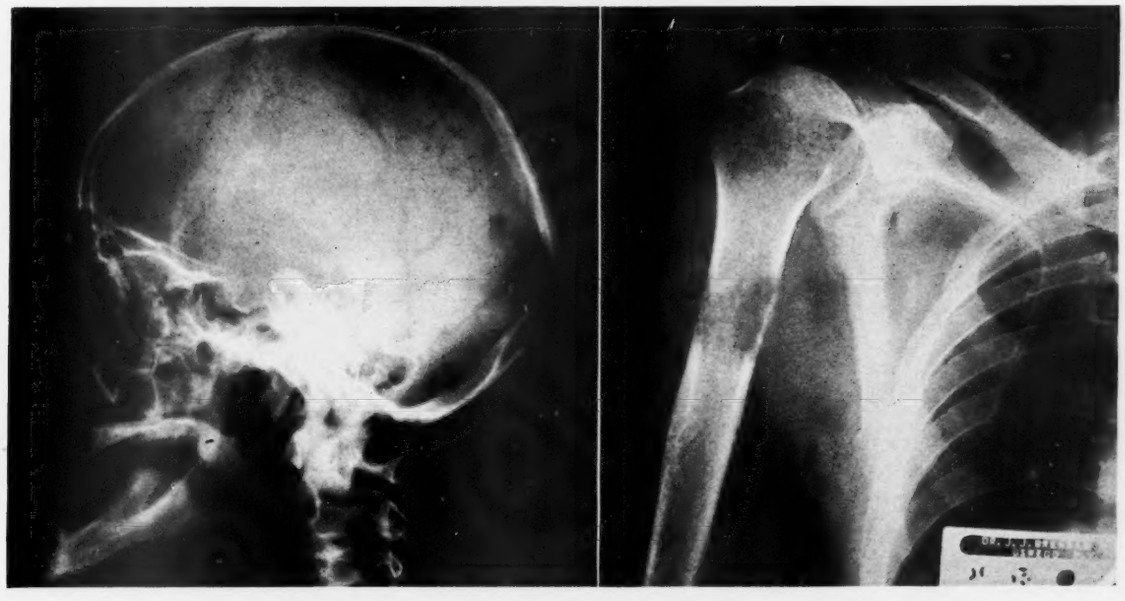
FIG. 5. Case III. Biopsy from bladder tumor showing papillary carcinoma invading the deeper layers of the bladder mucosa.

CASE II. S. M., No. 1837, forty-seven years old, a white, male, was admitted to the hospital April 16, 1930. The patient gave a history of intermittent hematuria of ten years' duration. Six months prior to admission he complained of inability to walk due to gradually increasing pain and lameness in his left hip. On examination, swelling and tenderness of the left hip were found. This swelling extended well down into the soft parts of the thigh. The *x*-ray picture revealed an osteolytic lesion, evidently metastatic in nature, involving the inner side of the upper third of the femur extending into the femur neck and into the lesser trochanter. Foci of bone destruction were present also in the acetabulum and in the inferior ramus of the ischium. (Fig. 3.) No roentgenological evidence of lung metastases was found. On cystoscopic examination the bladder cavity was found to be filled with extensive infiltrating papillary tumors. Biopsy from the tumor of the bladder showed a papillary carcinoma of comparatively low grade malignancy composed of regularly arranged, well differentiated squamous cells. (Fig. 4.) Palliative 200 kilovolt *x*-radiation over the primary and secondary tumor had no effect and the patient died on August 28, 1930, four months after admission. No autopsy was performed.

This case proves the potential malignancy of comparatively low grade, malignant, papillary carcinomas of the bladder.

Although the primary tumor revealed little histological evidence of malignancy after having been present for more than ten years, metastases developed in the femur and ischium. It also is apparent that since such metastases have developed they prove to be much more malignant than the primary tumor as evidenced by their rapid extension.

A



B C

FIG. 6. Case III. A and B, one large and numerous small osteolytic areas in occiput due to metastatic involvement from papillary infiltrating carcinoma of the bladder; C, pathologic fracture of right humerus due to metastatic bone involvement.

CASE III. W. K., No. 25033, sixty-two years old, a white, male, was admitted to the hospital May 15, 1936. The patient stated that he had

intermittent painless hematuria of four weeks' duration. Cystoscopic examination revealed a papillary carcinoma about 3 by 4 cm. in diam-

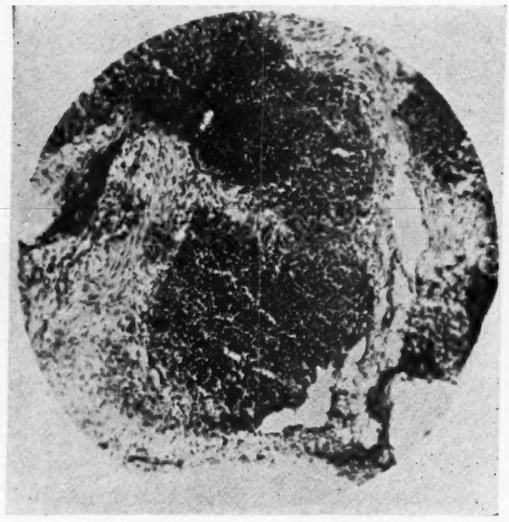


Fig. 7. Case IV. Biopsy from bladder tumor showing papillary infiltrating carcinoma invading submucosa.

eter in the region of the left ureteral orifice. Biopsy from the tumor showed a papillary carcinoma with evidence of beginning infiltration into the deeper layers of the bladder mucosa. (Fig. 5.)

Treatment of the lesion consisted of 200 kilovolt *x*-radiation and transurethral resection followed by radon seed implantation. Cystoscopic examination on January 11, 1937, revealed an apparently healed bladder. The patient remained well until September, 1940, at which time a papillary recurrence 3 mm. in diameter was discovered at the border of the scar and it was destroyed by electro-coagulation. Two months later when the patient returned for re-examination no evidence of tumor growth was visualized on cystoscopic examination. However, he complained of pain in the region of the left occiput. Examination revealed an area of tenderness and swelling about 4 cm. in diameter in the left occipital region. *X*-ray plates of the skull showed an irregular somewhat rectangular area of bone destruction evidently of metastatic nature in the left occiput. Numerous punched out areas of from 0.5 to 1.0 cm. in diameter were also seen scattered throughout the entire occipital region. (Fig. 6A and B.)

The patient has not returned for re-examination since then but reports received from his family physician indicated that he has been failing rapidly.

In April 1941, metastatic osteolytic lesions, involving medulla and cortex of the right humerus developed, and shortly after a pathologic fracture of the right humerus occurred. (Fig. 6C.)* There also was enlargement and ulceration of the lymph-nodes in the right axilla. Later a general carcinosis with involvement of all lymph-nodes developed, although according to the latest report the patient was still alive in December 1941.

In Case III distant metastases from carcinoma of the bladder developed, although the treatment of the primary lesion seemed to be successful. In this patient no macroscopic evidence of the primary tumor was present at the time when metastatic bone involvement became apparent. It may be presumed in such cases that living tumor cells underneath the surface of the scar or bladder mucosa are responsible for the spread of the disease. A case reported by Leadbetter and Colston is of interest in this connection. Their patient developed a brain metastases although the bladder showed no macroscopic evidence of tumor on autopsy. However, on microscopic examination active tumor cells were found embedded in the scar and in the deeper layers of the wall of the bladder.

Case IV. F. R., No. 42068, fifty-seven years old, a white, male, was admitted to the hospital June 4, 1941. The patient gave a history of intermittent painless hematuria of ten months' duration. During the past two weeks he complained of increasing pain in the left hip. Cystoscopic examination revealed multiple papillary infiltrating tumors of from 1½ to 5 cm. in diameter, the largest tumor being located high in the left posterior wall of the bladder. Biopsy showed that the tumor was a papillary carcinoma of the squamous cell type and some evidence of infiltration into the submucosa was noted. (Fig. 7.) A pelvic girdle plate, made on the day of admission (Fig. 8A) revealed no pathological condition in the left hip joint, however, an area of rarification of the bone structure in the lateral aspect of the

* Figure 6C courtesy of Dr. John J. Brennen, Oswego, N. Y.

superior ramus of the pubic bone was noticeable. In spite of *x*-radiation, the patient complained of increasing pain in the left hip and examination the entire left pelvic area was found to be infiltrated with a hard and nodular tumor mass. There was also marked edema

A B C D

FIG. 8. Case IV. A, small area of rarification of lateral aspect of anterior ramus of pubic bone suggests early metastatic involvement; B, five weeks later; rapid progression of metastatic lesion; C, four months later; complete destruction of lower half of left pelvic girdle and invasion of tumor into head of femur; D, cystogram showing displacement of bladder to the right side by large tumor mass filling left pelvis.

an *x*-ray picture made five weeks later showed an osteolytic bone lesion involving the lateral part of the superior ramus of the pubic bone. (Fig. 8B.) The patient returned for re-examination on October 20, 1941. He had severe pain in the left hip and was unable to walk. On inspection a tumor mass was visualized filling the left lower quadrant and on bimanual of the left leg. An *x*-ray picture of the left hip (Fig. 8C) revealed complete destruction of the superior and extensive destruction of the posterior ramus of the pubic bone. Marked involvement of acetabulum, ischium and ileum and invasion of the tumor into the femur head were also present. A cystogram showed the bladder to be displaced to the right side by a

large tumor mass filling the left pelvis. (Fig. 8D.) On cystoscopic examination marked progression of the lesion was found and since the patient's condition appeared hopeless no further treatment was given. He died January 6, 1942, seventh months after admission.

This case is of particular interest because it demonstrates the rapidity with which extension of metastatic bone involvement may take place once it has occurred. The metastatic lesion, which had affected only a small area in the anterior ramus of the pubic bone on admission, lead to almost complete destruction of the lower half of the left pelvis within four months.

The histological identity of the secondary bone lesion with the primary tumor of the bladder could be established only in the first of the four cases reported. In the remaining three patients the diagnosis was based on the roentgenological appearance of the bone changes and the symptoms produced by the secondary lesion. No evidence of a second primary carcinoma could be found in any of these three patients.

Severe pain in the affected parts of the skeleton was the outstanding symptom in all four patients and in Cases II and IV the pain was so severe that frequency of urination as well as marked dysuria were but secondary symptoms to the patient. The remaining two patients complained of little (Case I) or no bladder symptoms (Case III). Pathologic fractures occurred in two of the four patients while under observation (Cases I and III).

The primary tumor was of the solid infiltrating type only in one patient, while the remaining three patients had papillary carcinomas. This ratio is in agreement with the observation made before which was to the effect that large, destructive bone lesions seem to be encountered more frequently in the tumors of the papillary type than in solid carcinomas. If we add our four cases to the twenty-three collected from the literature, we arrive at twenty-seven patients, twenty of whom had papillary carcinomas as compared to seven who had solid infiltrating tumors. This observation is in contrast to statistics dealing with the group of cases with generalized metastases. The development of generalized metastases is encountered more frequently in patients with solid infiltrating tumors, the ratio being about 2 to 1 (Smith and Mintz) in favor of the solid cancers.

Neither extent nor degree of infiltration of a bladder tumor represents an indication as to the likelihood of the development of metastatic lesions (Kretschmer, Greenfield, Burkland and Leadbetter). Two of our three patients with papillary carcinomas had tumors, the histological appearance of which suggested a low degree of malignancy, and one of them responded so favorably to treatment that the bladder appeared cystoscopically free of tumor at the time when the presence of the metastatic lesion became apparent. It can be concluded, therefore, that potentially active tumor cells may rest embedded in the scar or in the bladder mucosa even if it is believed that the tumor has been eradicated. These active cell rests may occasionally well be responsible for the formation of late metastases.

In all cases of carcinoma of the bladder the possibility of the development of bone metastases must be borne in mind. *X*-ray pictures should be taken if signs and symptoms develop which suggest the presence of metastatic bone involvement. Such metastases may occur also in tumors of low grade malignancy as well as in tumors which respond favorably to treatment.

SUMMARY

Metastatic involvement of the skeleton is common in all cases in which widespread metastases from carcinoma of the bladder are encountered. However, cases with large bony metastases which dominate the clinical picture are comparatively rare.

Four cases of large osteolytic bone metastases due to carcinoma of the bladder are presented. In one of these four cases the primary tumor responded so favorably to treatment that no cystoscopic evidence

of the tumor was present at the time when the secondary lesion became apparent.

Neither extent nor degree of malignancy of a bladder tumor represents a reliable indication as to the likelihood of the development of extensive metastatic lesions including bone involvement.

Three of the four cases presented had papillary carcinomas and only one case had a solid infiltrating cancer.

Study of the histology of the primary tumor in twenty-seven cases (twenty-three cases collected from the literature and the four cases presented) suggests that large osteolytic bone metastases seem to develop more frequently in cancers of the papillary type than in the group of solid infiltrating carcinomas. This observation is in contrast to the fact that general carcinosis is encountered more frequently in solid infiltrating cancers of the bladder.

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ANOMALIES OF POSITION OF THE TRANSVERSE COLON

MAXWELL H. POPPEL, M.D. AND SAMUEL T. HERSTONE, M.D.
Radiologist, New York University Clinic — Resident in Radiology, Montefiore Hospital
NEW YORK, NEW YORK

THIS paper will concern itself primarily with marked gross congenital abnormalities in position of the transverse colon which may on occasion lead to serious clinical diagnostic errors. No attempt will be made to deal with apparent variations in position due to habitus, shape of abdominal cavity, paralysis or paresis of the diaphragm and abdominal musculature, or physiologic changes due to posture, respiration and digestion.

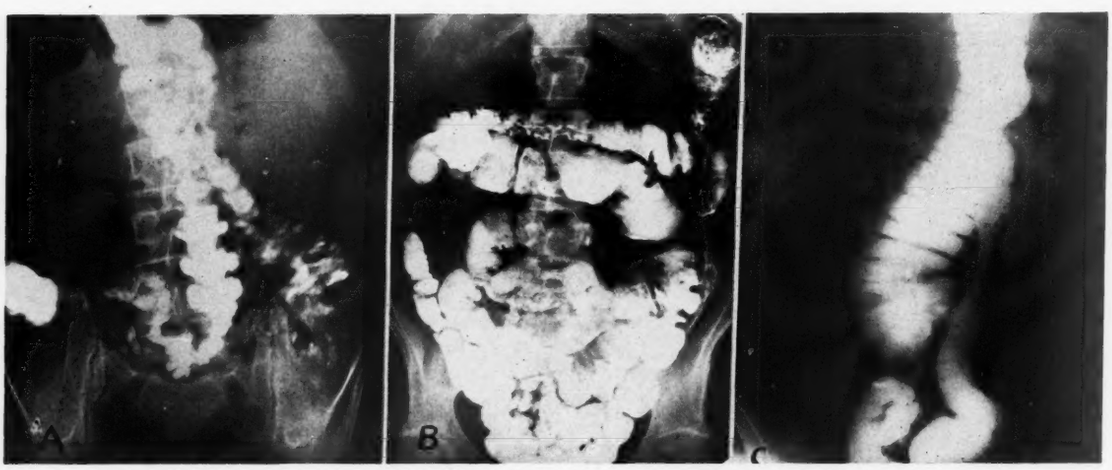

FIG. 1. A, Case I: Common mesentery with elimination of the transverse colon. B, Case II: Normal transverse colon with common mesentery causing the greater portion of the ascending colon to lie below and parallel to the transverse colon. C, Case III: Common mesentery with nonrotation of the gut; left diaphragmatic herniation.

Anomalies of position in the digestive tract, just as anomalies elsewhere in the body, are the result of some failure in normal development. In the digestive tract where normal disposition of the gut within the abdominal cavity is a result of many complex movements, fixations and variations in growth, it is not surprising that many bizarre and unusual abnormalities in position occur.

Anomalies may result from: (1) Abnormalities in growth—shortening or lengthening, resulting in redundancies; (2) abnormalities in migration—movement into and withdrawal from the umbilical sac, rotation or descent; (3) fixation—bands, common mesenteries or variations in length of mesenteries; and (4) associated congenital abnormality of neighboring organs, e.g., the diaphragm.

These disturbances in normal development may occur singly or in various combinations. Not uncommonly all four may be present in a single case. In such cases it may be difficult to distinguish between cause and effect. For example, occasionally the question arises whether a band or common mesentery is responsible for a defect in rotation or vice versa. Very often this question cannot be answered.

Abnormalities of growth have been discussed at great length by Bryant, Kantor and others. The distinction between the normal and the abnormal is sometimes at best arbitrary. These defects will, therefore, not be discussed in this paper except as they occur in association with other abnormalities in development.

For purposes of simplicity, the clinically important anomalies of position of the transverse colon have been classified into four main groups:

lie in the midline almost parallel to each other, both having a common mesentery, with elimination of the transverse colon. (Fig. 1A.)

Case II. In this case the cecum and

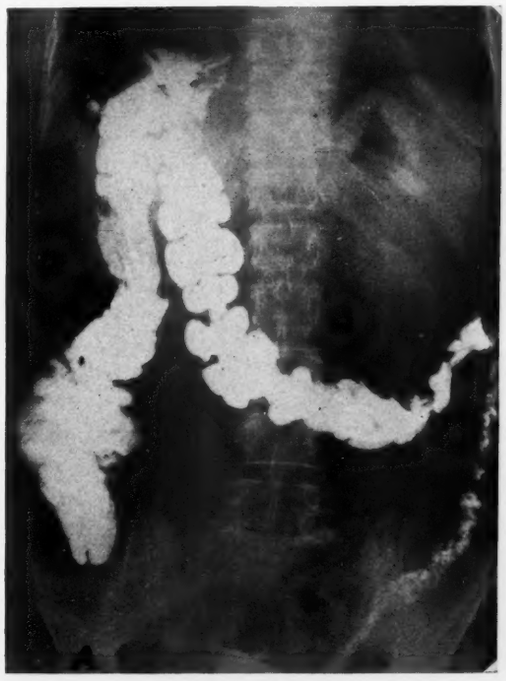

Fig. 2. A, Case IV.

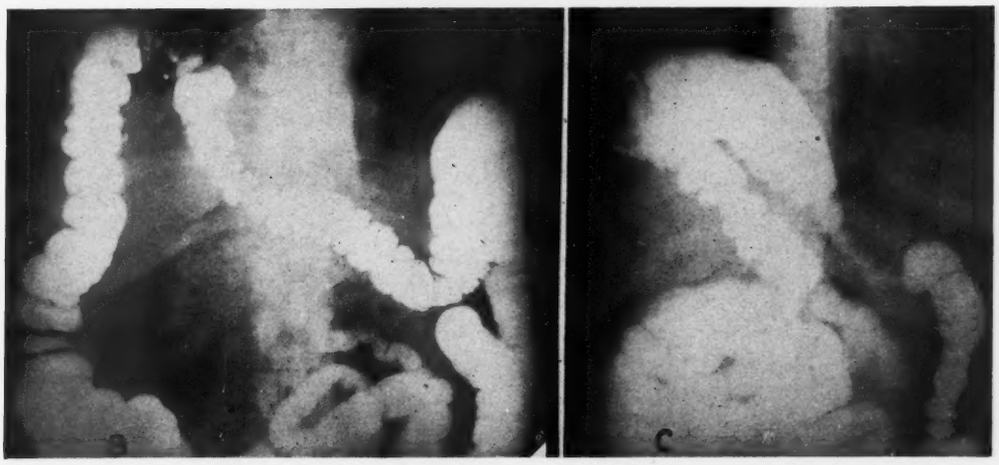

Fig. 2. B and C, Cases V and VI: Examples of interposition of the transverse colon by the liver and diaphragm.

I. Common Mesentery: This anomaly is primarily one of fixation, but is often found in combination with abnormalities in rotation and diaphragmatic herniation.

Case I. In this case normal rotation and descent have apparently taken place. The cecum is in the right lower quadrant, but the ascending and descending colon have come to

appendix are found to be in the left lower quadrant. It would seem that rotation and development have taken place normally, since the hepatic flexure is in the right upper quadrant. However, something has held the cecum in the left lower quadrant, resulting in an ascending and transverse colon lying parallel to and alongside each other. In this case the position of the transverse colon is

normal. This case is included in this series because of its allied interest. (Fig. 1B.)

Case III. This is the most extreme case of common mesentery. Here it is associated with nonrotation of the gut and left diaphragmatic herniation. The transverse colon is completely absent; the large intestine takes the shape of a hairpin, with but a single flexure lying high within the left chest. (Fig. 1C.)

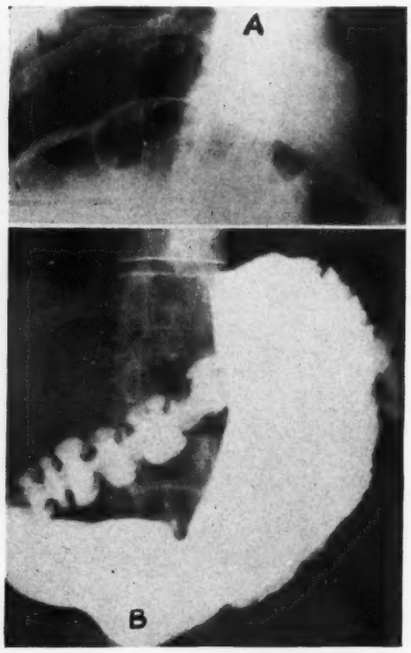

Fig. 3. A, Case VII: Bilateral interposition of the transverse colon. B, Case VIII: Interposition between the liver and anterior abdominal wall on the right and between the stomach and anterior abdominal wall on the left.

II. Interposition (Exclusive of Retroposition). This group of anomalies is not nearly so extreme as are those of common mesentery. Interposition of the transverse colon between diaphragm and adjacent structures may be congenital or may be secondary to paralysis of the diaphragm and ptosis of the liver. This paper is primarily concerned with those cases in which ptosis of the liver and paralysis of the diaphragm are not present. Even after these have been ruled out, it may not always be possible to say that the interposition is due to a developmental defect. However, since it is an abnormality which is not too uncommon, and one which occasionally results in serious diagnostic errors, it is worthy of consideration.

(*a*) *Left-sided Interposition.* Interposition of the colon between stomach and diaphragm and spleen and diaphragm is extremely common and one with which all radiologists are familiar. Undoubtedly, every radiologist has encountered difficulties in the study of the cardiac end of the stomach as a result of this abnormality.

(*b*) *Right-sided Interposition.* Interposition of the transverse colon between liver and diaphragm is much more unusual than left-sided interposition. This condition is of clinical importance, since on occasion it has led to an erroneous clinical diagnosis of diaphragmatic herniation. Cases IV, V and VI (Fig. 2A, B, and C), respectively, demonstrate this type of abnormality. Case V shows several diverticula near the hepatic flexure.

(*c*) *Bilateral Interposition.* This is a rare condition and is demonstrated in Cases VII and VIII.

Case VII. In this case the colon is running along the undersurface of the diaphragm from the right upper quadrant to the left upper quadrant. (Fig. 3A.)

Case VIII. This is a case of interposition between the liver and the anterior abdominal wall on the right, and the stomach and anterior abdominal wall on the left. This was confirmed in the oblique and lateral views. The colon is also shortened and has a slight upward arch. (Fig. 3B.)

III. Herniae of the Transverse Colon. These abnormalities usually occur as a result of persistence of the right or left pleuroperitoneal canals. Very rarely one sees complete absence of the diaphragm with most of the abdominal viscera in the chest. This, however, is incompatible with life and is of little concern to the radiologist.

(*a*) *Left-sided Hernia.* Case IX. Most of the colon is in the left chest. There is partial arrest of rotation. The cecum and appendix are in the region in which the left diaphragm normally should be. (Fig. 4A and B.)

CASE X. In this case rotation is normal. The splenic flexure is in the left chest, drawing the distal transverse colon upward. (Fig. 4C.)

(*b*) *Right-sided Hernia.* These are much rarer than those on the left side, but do occur.

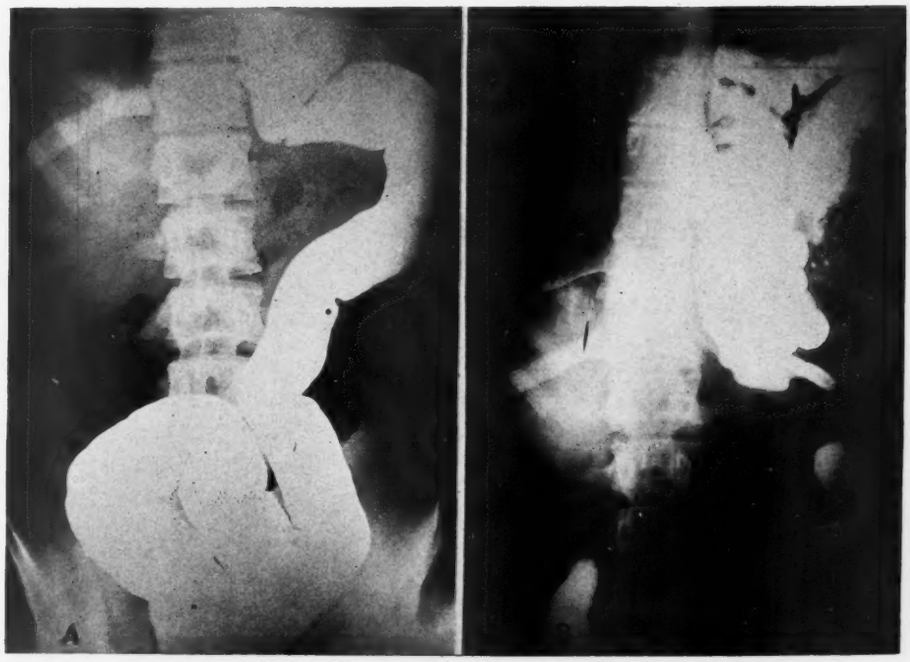

FIG. 4. A and B, Case IX: Most of the colon in the left chest; cecum and appendix are in the region in which the left diaphragm normally should be.

FIG. 4. C, Case X: Normal rotation; splenic flexure in left chest, drawing distal transverse colon upward.

CASE XI. This case demonstrates a diaphragmatic hernia associated with common mesentery and nonrotation. (Fig. 4D.)

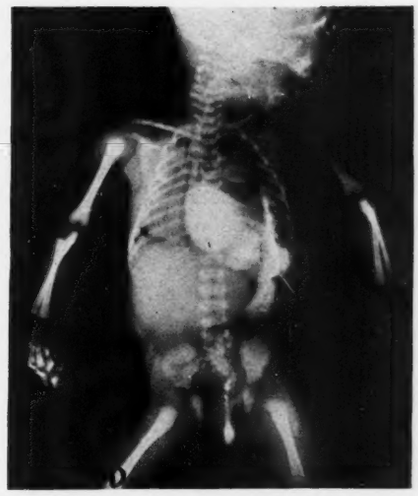

FIG. 4. D, Case XI: Diaphragmatic hernia associated with common mesentery and nonrotation.

(*c*) *Bilateral Hernia.* CASE XII. This is an extremely rare condition in which the ascending colon was seen to go through an opening in the right side of the diaphragm. The transverse colon then crossed from right to left within the chest and descended through an opening in

the left side of the diaphragm. It is hard to conceive how it could have developed embryologically, unless the transverse colon, or

Fig. 5. Case xii: Transverse colon in relation to the inferior and right borders of the heart; bilateral hernia.

what corresponded to it, entered the chest before formation of the diaphragm. The diaphragm then developed around it. (Fig. 5.)

IV. Retroposition. This condition is also exceedingly rare. Only a few cases are reported in the literature—thirteen, according to Truesdale. It is due to a rotation of the gut in a clockwise rather than a counterclockwise direction, resulting in a posterior position of the transverse colon in relationship to the stomach, duodenum and remaining small intestines. Figure 6 in Case xiii is a right oblique roentgenogram showing the transverse colon as it passes posterior to the stomach.

Fig. 6. Case xiii: Right oblique roentgenogram showing retroposition of the transverse colon.

CONCLUSION

This paper has concerned itself primarily with an illustrated description of the marked gross congenital positional anomalies of the transverse colon.

Thanks are due to Dr. Charles Gottlieb for the use of Cases iii and xii.

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CLINICAL STUDIES OF LIVER FUNCTION*

I. THE EFFECT OF ANESTHESIA AND CERTAIN SURGICAL PROCEDURES

C. R. SCHMIDT, M.D.
Director of Research, Hertzler Clinic

R. T. UNRUH, M.D.
Resident Surgeon, Hertzler Clinic

AND

V. E. CHESKY, M.D.
Associate Surgeon, Hertzler Clinic

HALSTEAD, KANSAS

WITHIN the past decade the functional state of the liver has become a consideration of more than passing clinical interest in surgical patients lacking evidence of biliary tract or hepatic disease. It is becoming more and more apparent that the liver, a relatively "silent" organ with a tremendous functional reserve and regenerative ability, can be markedly deficient in this assumed factor of safety. More significant, increasing recognition is being given the fact that certain patients apparently normal in all respects possess a liver that can withstand ordinary living but, when an added burden is placed on this organ, the reserves prove distressingly limited. Clinical evidence of hepatic insufficiency frequently becomes manifest after operations on the biliary tract and following surgery on toxic goiters; but, as Boyce has emphasized repeatedly, subnormal hepatic function following operation is by no means confined to this group of surgical patients.[3,5]

During the past two years we have studied over 600 medical and surgical patients with several tests of liver function run serially. Our observations have confirmed in nearly all respects those reported by Boyce[2,3,4] which make this worker's studies more significant. Much of his material has been obtained on charity patients, many of whom were colored and whose diet and living conditions may be assumed substandard. The subjects we have studied were all private cases from a somewhat higher social stratum, nevertheless, unexpected hepatic insufficiency was encountered in a surprisingly high number. We have satisfied ourselves that the liver plays an extremely important rôle in influencing postoperative morbidity and are in full accord with Boyce's concept of the "liver weakling"—an apparently normal individual with limited hepatic reserve who withstands a serious illness or an elective surgical procedure poorly, frequently developing clinical evidence of deficient hepatic function.

Studies of the functional state of the liver in goiter patients, before and after surgery, have been reported by us elsewhere.[7] Sixty per cent of 200 consecutive, unselected patients admitted to the goiter service revealed evidence of subnormal liver function. This figure is without regard for the type of goiter present or the age of the patient. Greatest impairment of liver function was observed in diffuse toxic hyperplastic goiter and in goiters of long standing with essentially normal basal metabolic rate (chronic hyperthyroidism). Specific therapeutic measures directed at a damaged liver were more effective in improving liver function when combined with the usual preoperative measures than when only the measures now in general use were employed alone.[7,10] A correlation between the functional state of the liver *postoperatively* and morbidity was observed.

This report concerns the effect of certain anesthetics and operative procedures on

* From the Hertzler Clinic and the Surgical Service of the Sisters of St. Joseph Hospital, Halstead, Kansas.

liver function as measured by the hippuric acid test. We believe this test, which measures both the ability of the liver to synthesize and to conjugate, is concerned with an extremely important hepatic function, i.e., the function of detoxication. Benzoic acid, itself nontoxic in the dose administered in the hippuric acid test, is handled by the liver like a toxic substance. It is conjugated with glycine to form hippuric acid which is excreted in the urine. Impaired ability of the liver to detoxify and postoperative morbidity are closely related. Patients with subnormal liver function after operation have been observed to display a stormier postoperative course than subjects who have no difficulty in synthesizing hippuric acid from sodium benzoate. While it is impossible to predict on the basis of preoperative liver function the degree of impairment that an anesthetic and operative procedure will induce, it has been observed repeatedly that patients with subnormal liver function before operation prove poorer risks than patients without evidence of functional hepatic insufficiency.

We have made a comparative study of liver function in patients using the hippuric acid test, the bromsulfalein dye excretion test, prothrombin time, and blood amylase determinations.[12] Positive results by all of the tests were obtained in patients presenting clinical evidence of hepatic insufficiency; however, the hippuric acid test and prothrombin determinations made serially have proved the most satisfactory index of hepatic function in border-line cases, as well as in certain definitely poor risk patients who showed subnormal hippuric acid synthesis and diminished prothrombin values with both normal dye elimination and blood amylase values. This is not surprising when one considers the number and variety of hepatic functions. Of the various tests available we believe that the hippuric acid test run serially is most suited as a laboratory aid in helping to evaluate a patient as a surgical risk. At the same time, we agree wholeheartedly with Boyce that no test or group of tests can be substituted for surgical judgment and clinical wisdom. While a "normal" hippuric acid test is in no way any guarantee of a patient as an operative risk, persistently subnormal values by the test are a warning of questionable hepatic reserve in the event such a patient is to be subjected to the added load of surgical trauma and an anesthetic. Such patients can be made better surgical risks by specific measures aimed at improving the functional state of the liver.[5,10]

Considerable animal experimentation has established the fact that the volatile (inhalation) anesthetics readily damage the liver. Chloroform is the most hepatotoxic with ether, ethylene and nitrous oxide next in order. It has been shown repeatedly that a liver rich in glycogen withstands anesthesia better than one depleted of glycogen. Also administration of oxygen along with the anesthetic likewise decreases liver damage.

Comparatively few studies have been reported on patients subjected to anesthesia and surgery in whom tests of liver function were performed both before and after the operation. Cantarow, Gartman and Ricchiuti[6] studied sixty patients subjected to simple cholecystectomy utilizing serum bilirubin and retention of bromsulfalein as a measure of hepatic function. They were unable to correlate the type or duration of anesthesia with postoperative drop in liver function following nitrous oxide and ether, infiltration of procaine hydrochloride, and spinal anesthesia type not specified. In twenty-six of forty-one patients (63 per cent) with apparently normal preoperative hepatic function a temporary increase in serum bilirubin was observed; retention of dye after operation was observed in 39 per cent of this group. Coleman[8] studied hepatic function in 100 patients subjected to surgery under various anesthetics. Retention of bromsulfalein and blood bilirubin in some were used as an index of hepatic function. Of thirteen patients receiving avertin 77 per cent showed retention of dye on the first day after

operation and 16 per cent still showed evidence of hepatic dysfunction on the seventh postoperative day. Of forty-nine patients operated upon under nitrous oxide-oxygen-ether anesthesia 51 per cent were unable to remove the dye in the allotted time one day after operation; by the seventh postoperative day 4 per cent still showed impaired dye clearance. Of eight patients subjected to spinal anesthesia 50 per cent showed evidence of functional liver damage on the day after operation; all had normal function on the seventh postoperative day. Thirty three per cent of twenty-seven patients operated upon under nitrous oxide-oxygen, and one patient operated upon under ether showed bromsulfalein retention on the first day, and two patients subjected to local anesthesia revealed no evidence of hepatic dysfunction. Boyce,[3] using the Quick hippuric acid test, studied an unspecified number of presumably normal patients subjected to elective surgery. Liver function was estimated before operation and on the first, second, third, seventh and fourteenth days postoperatively. Spinal anesthesia produced a drop of 49 per cent. Following ether a drop of 25 per cent was observed, while ethylene reduced hepatic function by 21 per cent.

EXPERIMENTAL DATA

All patients in this series were considered good operative risks and, except for patients undergoing cholecystectomy, were given no special preparation to improve liver function prior to operation. The hippuric acid test was performed usually on the day before operation and again on the first or second and the eighth days postoperatively. In a number of instances in which no drop in function was observed immediately after surgery the test on the eighth day was omitted.

Spinal Anesthesia. Spinal anesthesia was induced by the intradural introduction of crystalline novocain dissolved in spinal fluid. Two cc. of spinal fluid were withdrawn and from 1½ to 2 cc. containing from 150 to 200 mg. of novocain were re-introduced. An intramuscular injection of ephedrine in dosage of 50 to 75 mg. was always administered prior to the intraspinal injection. Blood pressure determinations and pulse rate were taken by an assistant routinely at frequent intervals throughout the operation.

Table 1 shows the effects obtained on twenty-one patients between the ages of nineteen and seventy-one years subjected to a variety of surgical procedures under spinal anesthesia. In eighteen (85 per cent) the first postoperative test showed essentially no reduction or the decline was such that liver function still remained within the lower limits considered normal (4.5 Gm. or 90 per cent). In a few instances, so designated in Table 1, the hippuric acid test was delayed until the second day after operation because the test solution produced nausea and could not be retained. Use of the intravenous modification of the hippuric acid test[9] was not done because on comparing values obtained by the oral and intravenous technics, run on consecutive days in twenty subjects having normal values with the oral method, we were unable to establish a satisfactory correlation which would justify such a substitution in a study of this sort.

It is interesting, and perhaps significant, that in two of the three patients showing a postoperative drop in liver function a marked transient fall in blood pressure occurred during the operation. In both adrenalin subcutaneously promptly elevated the blood pressure to its former level where it was maintained. It is possible that a state of temporary anoxemia secondary to a fall of blood pressure to shock levels, though only transient, could produce some degree of liver damage. Since no determinations of arterial oxygen saturation were made during the period of hypotension such an explanation is purely speculative. The reason for the drop in liver function from 85 to 62 per cent in the patient No. 21, age seventy-one, is unknown. The post-

operative period was not stormy and recovery was uneventful.

Ether. Ether anesthesia, administered by the open drop method to sixteen female patients between the ages of twenty-three and sixty-three years decreased liver function by 11 to 60 per cent with an average of 33 per cent (Table II). Three patients (Nos. 29, 30 and 33) with initial liver function tests of 108, 96 and 100 per cent gave values of 44, 50 and 44 per cent, respectively, on the day following surgery. Subject No. 29 was a sixty-three year old lady with carcinoma in both breasts. Bilateral radical mastectomy was performed with a surgeon working on each side simultaneously. Ether was administered from forty-three minutes. It is not unlikely that the magnitude of such an extensive operative procedure as bilateral radical mastectomy was a factor in the observed 60 per cent drop in liver function. The other two patients were in their early twenties; in one (No. 30) ether was administered for an hour and fifty-four minutes, in the other (No. 33) for thirty-eight minutes.

While the ether series is too small to warrant sweeping conclusions, there is a rough correlation between duration of anesthesia and drop in liver function (Nos. 30, 32 and 35). Likewise, the majority of those patients whose abdomens were opened (Nos. 32, 33, 34 and 37) tended to exhibit lower liver function after operation

TABLE I

EFFECT OF SPINAL ANESTHESIA AND SURGERY ON LIVER FUNCTION

No.	Sex	Age	Hippuric Acid Test* Four-hour Output (Gm.)*			Operation
			Pre-operative	Postoperative		
1	F	45	4.86	4.78[1]	4.90[8]	Perineorrhaphy, uterine suspension
2	M	19	3.80	3.76[1]	.....	Hernioplasty; pituitary dystrophy
3	F	59	4.38	4.22[1]	.....	Uterine fixation
4	F	59	5.21	4.77[1]	5.13[17]	Cauterus, laparotomy
5	F	53	6.10	5.68[2]	.....	Gallstones; cholecystectomy
6	F	51	4.64	4.52[2]	.....	Gallstones; cholecystectomy
7	F	50	5.09	4.86[1]	5.00[10]	Gallstones; cholecystectomy
8	M	42	5.92	5.18[1]	.....	Gallstones; cholecystectomy
9	F	59	4.96	4.56[1]	.....	Hysterectomy
10	F	51	6.88	6.14[1]	.....	Perineorrhaphy, uterine fixation
11	F	48	4.59	4.48[2]	.....	Fibroids, hemorrhage; hysterectomy
12	F	33	4.74	4.47[1]	.....	Perineorrhaphy, uterine suspension
13	F	37	5.53	5.93[2]	.....	Defundation
14	F	71	4.54	4.68[2]	.....	Dilatation and curettage cancer of cervix
15	F	30	5.60	5.54[1]	5.23[8]	Endometrioma, excision
16	F	63	5.23	4.93[2]	.....	Perineorrhaphy, uterine fixation
17	F	58	4.72	4.95[2]	.....	Dilatation and curettage
18	F	46	5.38	4.50[1]	.....	Amputation leg
19	F	57	6.70	†3.73[1]	4.58[4]	‡Uterine fixation; saphenous ligation
20	F	55	6.47	†2.43[2]	5.16[17]	Gallstones; cholecystectomy
21	F	71	4.26	3.14[1]	4.30[8]	Vaginal hysterectomy
Average.....			5.23	4.83§	4.90	

* Average output one hundred fifty "normal" patients 5.0 Gm. in four hours following ingestion of 6 Gm. sodium benzoate; 4.5 Gm. considered lowest limits of normal.

† Fall in blood pressure during operation.

‡ Hippuric acid test 6.08 Gm. on twelfth postoperative day. Small numerals in postoperative columns designate day of test.

§ Excluding No. 19 and 20.

than the patients undergoing mastectomy, hemorrhoidectomy and nephropexy. In all of these patients liver function was within the range of normal before surgery. A drop of liver function to 40 to 60 per cent of normal was invariably attended by increased morbidity during the first few days following operation, after which uneventful recovery was the rule. One wonders, however, what the outcome would be if a patient with a significantly subnormal liver function, say 50 or 60 per cent of normal, were subjected to a major operation under ether. We have some information on this point concerning poor risk patients operated upon under spinal anesthesia.[11]

TABLE II

EFFECT OF ETHER ANESTHESIA ON LIVER FUNCTION

No.	Age	Hippuric Acid Output in Four Hours—Gm.*				Per Cent Change	Operation	Duration of Anesthetic, Minute
		Preoperative	Postoperative					
			1	2	3			
22	36	5.20	3.90[1]	5.36[8]	.....	−25	Excision of breast tumor	25
23	53	5.10	3.80[2]	4.22[7]	5.60[17]	−26	Radical mastectomy	38
24	48	4.29	3.74[1]	4.50[8]	.....	−13	Radical mastectomy	33
25	61	6.09	3.57[1]	6.29[8]	.....	−41	Radical mastectomy	
26	33	....	4.41[2]	5.31[5]	5.52[7]	−20†	Radical mastectomy	36
27	41	5.00	3.33[1]	4.90[8]	.....	−33	Radical mastectomy	38
28	54	....	3.94[2]	4.41[8]	.....	−11†	Radical mastectomy	30
29	63	5.40	2.21[1]	5.31[7]	.....	−60	Bilateral radical mastectomy	43
30	23	4.84	2.51[1]	5.58[10]	.....	−48	Plastic on breasts	114
31	46	4.80	3.97[2]	4.39[6]	.....	−17	Hemorrhoidectomy	9
32	44	5.80	3.57[1]	5.71[8]	.....	−38	Perineorrhaphy, uterine fixation	48
33	24	4.98	2.21[1]	5.16[7]	.....	−55	Perineorrhaphy, uterine fixation	38
34	31	5.18	3.28[1]	5.40[8]	.....	−37	Bilateral salpingectomy, fixation	62
35	42	5.60	3.55[2]	5.20[8]	.....	−37	Vaginal hysterectomy	51
36	51	4.54	3.88[1]	4.98[8]	.....	−14	Nephropexy	57
37	50	4.14	2.16[1]	.....	.....	−48	Cholecystectomy	30
Average...		5.07	3.38	5.10	.....	−33		

* Normal = 5.0 Gm.; 4.5 Gm. considered lower limits of normal. Small numerals in postoperative columns designate day of test.

† Difference between column 1 and 2 or 3.

Avertin. Avertin ordinarily is used as a basal analgesia in combination with one of the volatile anesthetics, most commonly ethylene. Bourne and Raginsky observed that avertin produced little or no evidence of impaired removal of bromsulfalein by normal livers in dogs but that animals with dye retention evidenced even greater retention, indicating increased liver damage after avertin.[1]

We have studied liver function in seven patients before and after a surgical procedure under avertin narcosis. (Table III.) Thyroidectomy was done in six of the seven patients receiving avertin as a basal anesthetic (80 to 90 mg. per kilo body weight administered rectally). In addition to the avertin the thyroid region of the goiter patients was infiltrated with two ounces of 0.5 per cent novocain. The remaining patient had a carcinoma of the jaw and avertin was the only medication given. A drop in liver function of 5 to 30 per cent was observed on the second postoperative day. Two of the six patients with goiter presented clinical evidence of a quite toxic

goiter (Nos. 43 and 44). Liver function dropped 25 and 30 per cent, respectively, following operation. Patient No. 44 had a diffuse hyperplastic goiter and required special preparation to raise the hippuric acid test to the normal range before operation. Only because of an idiosyncrasy to both morphine and the barbiturates was avertin used in this patient. The surgical procedure was restricted to hemithyroidectomy, yet postoperative liver function was diminished more than in any other well prepared hemithyroidectomized patient under our observation during the past two years; and this in spite of therapeutic measures to bolster liver function during the first two days after operation. Although the first three postoperative days were stormy, the patient was never in critical danger.

TABLE III

EFFECT OF AVERTIN ON LIVER FUNCTION

(80 to 90 mg. per kilo body weight)

No.	Sex	Age	Hippuric Acid Output in Four Hours		Per Cent Change	Diagnosis and Operation
			Pre-operative	Post-operative*		
38	M	46	4.05	3.00	−26	Carcinoma jaw, excision and cautery
39	M	40	5.20	4.97	− 5	Nodular colloid goiter, thyroidectomy
40	F	44	6.00	5.29	−12	Nodular colloid goiter, thyroidectomy
41	F	41	5.89	5.23	−11	Fetal adenoma, right; lobectomy
42	F	29	4.76	4.00	−19	Nodular goiter; thyroidectomy
43	F	36	5.91	4.39	−25	Recurrent goiter; thyroidectomy
44	F	25	4.73	3.31	−30	Toxic diffuse goiter; hemithyroidectomy
Average.....			5.22	4.31	−17	

* Tests made on second postoperative day.

Boyce[3] has found that ethylene anesthesia diminished liver function by an average of 21 per cent in apparently normal subjects undergoing elective surgery. It seems reasonable that the depressing effects of avertin plus ethylene would be cumulative. Theoretically at least, this would add

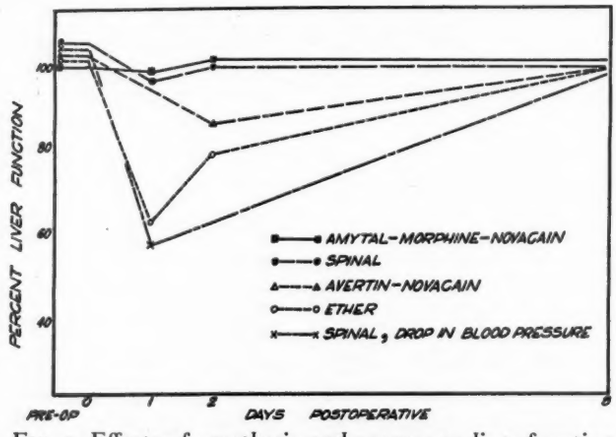

FIG. 1. Effects of anesthesia and surgery on liver function by the hippuric acid test in surgical patients. Compiled from data on forty-four patients tabulated in Tables I, II and III, and on forty patients operated upon under amytal-morphine-novocain anesthesia.

up to a 50 per cent decrease in liver function, a sizeable load to put on a patient with a very toxic goiter. A study of the effect of avertin plus ethylene anesthesia on liver function in toxic goiter should be made.

Local Anesthesia. Local anesthesia is still used widely in this clinic for surgical procedures other than thyroidectomy. We have accumulated data on the effect of surgical procedures under local anesthesia on liver function in over forty patients. Predominant in this group are nontoxic goiters, hernioplasties, skin grafts, neck tumors and cysts and benign tumors of the breast. Unless the patients are very young or very old the preoperative sedation is the same for all: 6 gr. of amytal and 1/6 gr. (H) of morphine sulfate two hours before and 1/6 gr. (H) of morphine one hour before surgery. The effect on liver function of this sedation together with from one to three ounces of 1/2 per cent novocain infiltration has been so consistently negative that we consider it pointless to tabulate the data. (Fig. 1.)

COMMENT

We have confirmed so many of Boyce's observations on liver function in surgical patients that we are at a loss to understand the conflict between his results on spinal anesthesia and those obtained by us. Boyce[5] recognizes that a blood pressure drop may have been a factor in the liver insufficiency he observed after spinal anesthetics, yet no data on either blood pressure readings or arterial oxygen saturation were presented. The two patients with blood pressure drops in our spinal series suggest that hypotension reaching shock levels is followed by diminished liver function. Anoxia of the hepatic parenchyma seems the most likely explanation. This point is deserving of further study.

While our data on ether would appear to indict this anesthetic as a potential hepatotoxin, practical reasoning eliminates such a conclusion so far as patients with normal livers are concerned. The diminished liver function observed in our patients was only a temporary one indicative of *functional* and not organic damage. While postoperative morbidity was more prevalent after ether, recovery was prompt and after two or three days the postoperative courses were the same for both the spinal and ether cases. On the other hand, given a poor risk patient whose liver function is subnormal due to probable organic damage the selection of an anesthetic would become a point of importance. It seems that spinal anesthesia, administered with measures to sustain blood pressure, would offer less hazard to the poor risk patient than ether administered by the open drop method. Our mortality statistics on patients with gallbladder disease undergoing cholecystectomy during the past fifteen years bears this out, although a decreased incidence of pulmonary complications following spinal anesthesia and better preoperative preparation for surgery undoubtedly are important factors in a decreased mortality.

Avertin analgesia as a basal anesthetic in patients with goiter produces a slight impairment of liver function. In mildly toxic goiters such a side effect is negligible, nevertheless, it is an effect on the liver that is not encountered following the administration of amytal and morphine for preoperative sedation. (Fig. 1.) Our limited experience with avertin suggests it may possess more pronounced hepatotoxic effects in toxic goiter.

A more practical disadvantage in using avertin as a basal analgesia in combination with novocain infiltration is absolute loss of co-operation during the operative procedure on the part of the patient. The majority of patients operated upon under avertin-novocain, though unconscious, required restraint to prevent involuntary thrashing movements. This is never encountered with the patient under amytal-morphine-novocain sedation during thyroidectomy. Much has been written about the "psychic trauma" incident to thyroidectomy under local. We had never quite understood this term until thyroidectomy was attempted under avertin-novocain. Psychic trauma was encountered then

face to face, not by the patient, but by the surgeon striving to accomplish a delicate task on an operative field that changed its locale every few minutes because of involuntary movements by an unconscious patient who, limp and snoring one moment, would all but climb from the operating table the next.

To be able to perform thyroidectomy on a conscious, quiet, co-operative patient is extremely advantageous to the surgeon. It is the only way he can judge accurately throughout the operation the patient's reaction to thyroidectomy. Any undue restlessness or tachycardia during the operation is a warning which permits alteration of the operative procedure accordingly. Many of our patients, prepared for bilateral operation, have been subjected to hemithyroidectomy only because their reaction on the table made it clear that they were not the bona fide risks we had considered them. Such evaluation of a patient with a goiter during surgery is impossible in patients rendered unconscious by an anesthetic. There can be little doubt but that this one important advantage of local anesthesia has been a great factor in a mortality rate of well under 1 per cent reported by us recently.[7]

SUMMARY

The effect of certain anesthetics and various operative procedures on liver function was studied in eighty-four patients before and after operation, using the hippuric acid test as an index of hepatic function. All of the patients studied were considered good operative risks and were without evidence of functional liver insufficiency before operation.

Spinal anesthesia produced the least evidence of hepatic dysfunction in twenty-one patients subjected to a variety of operative procedures. In eighteen patients (85 per cent) liver function averaged 104 per cent before operation and 96 per cent on the first or second day after operation. In two patients in whom a transient fall in blood pressure occurred on the operating table, the postoperative hippuric acid tests fell to 74 and 49 per cent, respectively, and then returned to normal within seventeen days.

Ether anesthesia produced transient subnormal hepatic function in all of sixteen patients. An average liver function of 101 per cent before operation was reduced to 67 per cent. By the end of one week normal values were again obtained.

Avertin given as a basal anesthetic in combination with novocain infiltration reduced liver function by 5 to 30 per cent in seven patients.

Amytal and morphine given as preoperative sedation to forty patients operated upon under novocain infiltrated locally produced no change in the functional state liver as reflected by the hippuric of the acid test.

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THROMBOCYTOPENIC PURPURA

JOHN ROBERTS PHILLIPS, M.D. AND MARTIN A. ZIONTS, M.D.
Visiting Surgeon, St. Joseph's and Memorial Hospitals
Visiting Physician, St. Joseph's and Memorial Hospitals
HOUSTON, TEXAS

THROMBOCYTOPENIC purpura is characterized by a diminution of the blood platelets. The first case was reported in 1735 by Werlhof. Brohm, in 1881, and Denys, in 1887, were the first to describe and emphasize that the essential finding was the lowered platelets in the peripheral blood. Hayem noted the normal clotting time and the absence of clot retraction. Duke, in 1910, showed the prolonged bleeding time. The first splenectomy for the condition was performed by Kaznelson in 1916.

Purpura hemorrhagica can be classified in many ways, but since we are only discussing thrombocytopenic purpura, we are limited to the symptomatic and the idiopathic type. Symptomatic purpura is that in which we find the purpura as an incidental finding or secondary finding along with the primary disease. This study was made on twenty-three cases, seven of these cases were of the symptomatic type and sixteen were of the idiopathic type. Eleven patients of the idiopathic type were splenectomized.

The various causes of the symptomatic type are: (1) blood dyscrasias, as leukemia, pernicious anemia, splastic anemia. In the series of cases studied there were three good examples of the type:

One was a four-year old white male admitted to the Hospital in 1941 with the symptoms of hemorrhages from the mouth and purpura. The blood findings were: platelets 11,500, white blood count 3,100 with 77 per cent lymphocytes, absent clot retraction, bleeding time five minutes. Splenectomy was performed; there was momentary rise in the platelet count, but the child did not improve. One month later the bleeding time was forty-nine minutes, the platelets 9,300, lymphocytes 88 per cent. One week later the white blood count rose to 39,000 with 95 per cent lymphocytes and the diagnosis of leukemia was made. This was confirmed at autopsy.

Another case, a seventeen-year old male was sent into the hospital as a case of purpura, but the diagnosis of leukemia was proved before splenectomy was contemplated. Still another was a twenty-year old white female admitted to the Hospital in 1938 with purpura and bleeding from the gums of three to four months' duration. Examination showed bleeding gums, purpuric spots, and a nonpalpable spleen. The tourniquet test for capillary fragility was positive, platelets varied from 10,000 to 30,000, white blood count ranged from 2,000 to 3,800, clot retraction was absent, bleeding time was four minutes. On sternal aspiration no cells were obtained. Splenectomy was performed. The spleen was of normal size with a smooth capsule and prominent corpuscles. After the operation the patient oozed and oozed, was given transfusions several times but the hemorrhagic symptoms continued.

All three cases bring out a very important point, namely, unless all the findings of purpura are present and no other abnormal blood findings are present, hesitate to operate. In the two cases in which the diagnosis was finally made of leukemia, there was a leukopenia with a relative increase in the number of lymphocytes. In the third case, leukopenia and a sternal aspiration revealing no cells indicated the diagnosis of a possible aplastic anemia, hence the splenectomy should have been delayed for further studies.

2. Acute infections are sometimes accompanied by purpura with a thrombocytopenia as seen in typhoid, pneumonia, meningitis and occasionally with exanthemas. In this series there were two cases. One case was seen during the course of a rather septic pneumonia and the other in a small child with a large boil or carbuncle

of the neck. Both cases cleared rapidly with the healing of the causes of the thrombocytopenia.

3. Chronic infections also, are seen as a cause of a drop in the platelet count with resultant purpura. Tuberculosis and subacute bacterial endocarditis are the two chief offenders in this instance. There were no examples of this type in this series of cases.

4. Drugs are perhaps the most common cause of lowered platelet counts and the list of drugs which have been incriminated is a long one, but the most common are neoarsphenamine, quinine, sedormid, phenobarbital and the sulfonamides. An example of this is seen in a thirty-three-year old white female who was admitted in 1933 with a history of having intravenous injections for her syphilis for the three months previously. She had been menstruating for one month and on examination was pale, and had tenderness in the left lower quadrant. The white blood count ranged from 2,900 to 3,400; there was a marked anemia, the bleeding time was eight to fourteen minutes, the platelets were 4,000. She was given transfusions several times and the platelets slowly rose to 38,000. No follow-up was possible.

5. In cases of advanced malignancy with metastases to the bone marrow low platelet counts are sometimes seen.

6. In cases of splenomegalies such as Banti's, Gauchers or hemolytic icterus low platelet counts are detected. No cases of these last two types were seen in this series.

The idiopathic type of thrombocytopenic purpura is divided into two categories by the type of course they follow, namely, acute and chronic. The more common type of acute case is that which recovers for a while then goes on to a chronic form. Other forms are those in which there is a complete recovery and the patient is well completely. Some of these cases which appear as perfectly normal relapse after a varying length of time. Certain of the acute cases, in spite of all therapy, finally succumb, and in these cases various types of lesions may be found. One type of that which Rosenthal calls megakaryophthisis in which there is a marked diminution of the megakarocytes. In other cases one sees marked vascular changes with generalized small intravascular thrombi. In these fulminating cases the course of the disease may be very short as in the two cases reported by Denninger, wherein the entire elapsed time of symptoms was eight and one-half and eleven hours, respectively. In this series there were five acute cases with one fatality. This fatal case was one of the fulminating type, the child having symptoms for only thirty-six hours before the fatal termination. The other four cases recovered completely and left the hospital after transfusions.

The chronic type of idiopathic purpura hemorrhagica was seen in eleven instances and it is chiefly about these types of cases that this paper is concerned. This disease is most common in children and in young adults, especially girls. Of the sixteen cases, ten were in females whose average age was twenty-seven years. The etiology of the lowered platelets in these cases has been studied by many investigators and apparently there is more than one cause. Some of the workers believe that the vascular endothelium is injured and secondarily causes a fall in the platelets by causing their agglutination on the injured points. However, the majority of investigators are of the opinion that the essential factor is the platelets themselves and that they may be low in the peripheral blood because of poor production or by increased destruction. The lytic effect of the spleen on platelets was first suggested by Kaznelson in 1916. It is rather difficult to show phagocytosis of platelets in the spleen although it has been demonstrated. Poor production may be due to some substance elaborated by the spleen inhibiting the budding off of the platelets from the megakaryocytes, a sort of maturation defect; or it may be due to an actual depression of the megakaryocytes. This substance, thrombocytopen, has been demonstrated by Troland and Lee and recently

confirmed by Rose and Boyer. The majority of workers have been unable to confirm this.

The critical level of the platelets varies considerably in the opinion of various authors on the subject. However, in the great majority of cases purpuric phenomena occur when the platelet count is below 100,000. We believe that the best method for all practical purposes for the enumeration of blood platelets is the method of counting them in the blood counting chamber using a simple 3 per cent solution of sodium citrate as the diluent.

The symptoms of this disease are well known, they are: (1) hemorrhages into the skin, mucous membranes and internal organs. In these sixteen cases the most common site of the lesion was purpura of the skin and secondly, bleeding gums; (2) fever is not seen as a rule; though, in the acute cases this may be seen; (3) the spleen is only slightly enlarged although there are cases in which the enlargement has been pronounced; (4) when blood loss has been great, all the common symptoms of anemia will be present; (5) no adenopathy or hepatomegaly; (6) the white blood cell count is normal or there may be a slight leucocytosis with a normal differential or one which shows a slight increase in the polymorphonuclear count; (7) the platelets are diminished; (8) there is increased bleeding time; (9) absent clot retraction; (10) decreased capillary resistance, and (11) normal prothrombin time and coagulation time. This latter finding has been challenged by Nygaard who finds by his photo-electric technic that there is a delayed coagulation time in this disease.

In the chronic type, the platelets may be normal or decreased, though the capillary resistance and the tendency to bruise remain. One often sees exacerbations coinciding with the menses. Uterine hemorrhage may be the only symptom in these cases and the doing of the snake venom test is of differential value.

One should be on guard in those cases in which the amount of hemoglobin and red blood cells is too low compared to the actual blood loss and in which leukopenia is present. In these cases a very careful differential count should be done to rule out aleukemic leukemia. Furthermore, a study of the bone marrow is of great importance for several reasons: (1) to determine if there be any form of leukemia present; (2) if there be an aplasia of the bone marrow, and (3) if there be a normal decrease in the number of megakaryocytes. Reticulocyte counts are of value to determine if normal red cell regeneration is taking place. In this series three cases of purpura with a leukopenia were found (exclusive of the two cases of aleukemic leukemia) and in these cases the results were not good. One patient was operated upon with death as a result. The other two patients continued to have purpuric phenomena.

Since many of these cases have bleeding from the gums as a chief symptom, they go to the dentist first; therefore, it is of vital importance that the dentist be cognizant of the disease. Outside of the sternal marrow study, all tests can be performed with ease and and facility.

Wintrobe and his co-workers show that males as a rule recover from the first attack and hence the operation is more to be considered in females.

The differential of this disease is not hard if one recalls the necessary criteria that should be present. In the Henoch-Schoenlein type, joint pains and toxemia are frequent manifestations and these are not seen in the idiopathic type. Leukemia and aplastic anemia have been discussed. In hemophilia, there is a normal platelet count, normal capillary resistance, normal bleeding time and a marked prolongation of clotting time.

The spleen removed shows an endothelial proliferation of the Malpighian bodies and sinuses with an increase in the number of the reticulum cells throughout the whole organ. There is also seen an infiltration of polymorphonuclear eosinophiles and megakaryocytes. Occasionally, one sees phagocytosed platelets. In the bone marrow the

picture can be one of aplasia with megakaryopthisis normal with an anemia response of the red cell series or increased megakaryocytes with many young forms and poorly budding off of the platelets.

TREATMENT

Many types of medical management have been tried but most of them seem to have been of value only in the hands of the original investigators. Transfusion has been of value especially pre- and postoperatively and in the acute cases for whom operation is so dangerous. Many patients, especially children, have spontaneous remissions and remain well for the rest of their lives. This probably accounts for some of the results with some of the various medical methods of management in the acute cases. In some of the acute cases, the symptoms do not abate and one is forced into operating in order to attempt to save a life.

Treatment with calcium, vitamin C, vitamin K, horse serum, thromboplastin, foreign protein therapy, adrenalin injections, parathormone, *x*-ray and radium have all been tried with rather poor results in the hands of most of the men who have tried them. Snake venom has been used but there, too, the results have been none too good. But for a prognostic test the use of snake venom has been of some value. Cases in which the intracutaneous test became negative after treatment with snake venom responded well to splenectomy.

The most effective treatment is splenectomy. Ligature of the splenic artery was tried in two cases by Rosenthal and Berg and found to be of no value. As to preoperative care (1) be absolutely sure by all the tests at your command that this is a case of chronic idiopathic thrombocytopenic purpura, and (2) preoperative blood transfusion and preparation for postoperative transfusions should be provided. The operative technic will not be discussed except to mention one important point, namely, that no accessory spleen be left *in situ* to continue on with the mischief. Some of the poor results are undoubtedly due to overlooking this point. Hesitate before thinking too seriously of going back in to stop a bleeder that you imagine may be present in some of the more stormy cases.

The results in the acute cases in which operation was tried carried a much higher mortality (70 to 80 per cent). In chronic cases in which operation was performed the results were excellent with only 8 per cent mortality. In this series none of the patients with acute cases was operated upon. In the eleven chronic cases in which splenectomy was performed there were nine complete cures, one with symptoms remaining as before the operation but still alive after eight months. There was one death. The patient who died did not have as complete a workup as we would like to have seen in order to assess the case better. Two of the patients in this series had accessory spleens. The results of splenectomy as summarized by Rosenthal can be placed under the following groups: (1) complete recovery, (2) symptomatic recovery but platelets diminished in number, (3) complete recovery with a very high platelet count (thrombocythemia), (4) partial recovery with mild hemorrhages and thrombocytopenia, (5) persistent anemia with normal platelets and no hemorrhagic state, (6) unsuccessful splenectomy with partial recovery and then death, and (7) unsuccessful outcome with early postoperative death.

The following is the case history of a patient recently observed by us:

The patient, a nineteen-year old white female, three years ago first noted black and blue marks over her entire body. Thyroidectomy for hyperthyroidism was performed two and one-half years ago with no undue bleeding. One and one-half years ago she noticed a sudden increase in the bruising tendency. There never was any excessive menstrual flow. She was seen by several physicians and the following types of medical treatment were tried: blood intramuscularly, vitamin C, vitamin K, calcium and snake venom. After each new type of treatment there was an apparent improvement but the condition remained with her and

gradually became worse. Studies done at that time showed the following: platelet count never below 177,000, bleeding time seven to ten minutes, absent clot retraction, positive tourniquet test. Sternal marrow aspiration reported as normal.

When one of us (M. A. Z.) first studied her case she had the following: multiple ecchymoses, petechiae and some small hematomas. The spleen was not palpable. There was only a mild anemia. There was a normal white blood count and differential count and a normal bone marrow study. The bleeding time was six and one-half minutes. There was no clot retraction, a positive tourniquet test was present. The platelet count (chamber count) was 30,000. Splenectomy was performed several days later by one of us (J. R. P.). The spleen was just a trifle enlarged, the corpuscles were quite prominent. The platelet count postoperatively rapidly rose so that on discharge they were within normal limits; no new petechiae or ecchymoses developed. Today she is symptom free and her platelet count is normal.

SUMMARY

We have presented twenty-three cases of thrombocytopenic purpura, sixteen of which are idiopathic—the case for splenectomy. Eleven of these were chronic cases and were splenectomized. Seven were symptomatic and we believe that splenectomy in this group is not indicated.

The diagnosis is usually certain when care and attention is paid to the diagnostic criteria as set forth. Likewise when the diagnosis is certain splenectomy gives good results with small risk.

THE MODERN TREATMENT OF OSTEOMYELITIS*

HENRY W. MEYERDING, M.D. AND REED S. CLEGG, M.D.
Section on Orthopedic Surgery, Mayo Clinic
Fellow in Orthopedic Surgery, Mayo Foundation
ROCHESTER, MINNESOTA

THE use of chemotherapy in cases of osteomyelitis has led to revolutionary changes in the management of treatment for the disease. Pyogenic organisms that cause osteomyelitis pass through the blood stream to become localized, thus producing abscesses and destruction of bone with disabling results. The prevention and sometimes the cure of early osteomyelitis may result if chemotherapy is administered thoroughly during the stages when the infection of the blood stream or septicemia is recognized and if the treatment is instituted before abscess formation has taken place.

Osteomyelitis may be extensive, involving the medulla, cortex, periosteum, metaphysis and epiphysis or it may be limited to any one of these parts. The most frequent predisposing causes are low resistance accompanying disease, trauma, foci of infection and inflammatory lesions about the skin or nails where bacteria can enter the blood stream and extend into bone. Bacteria occasionally reach bone by direct extension. Septicemia may first be present and bacteria localizing in the end arteries of bone may produce osteomyelitis.

It is accepted generally that staphylococci, especially Staphylococcus aureus and Staphylococcus albus, are the exciting micro-organisms in 80 to 90 per cent of all cases of osteomyelitis and that streptococci are responsible for most of the remainder. Except for the more extensive course of infection caused by Staphylococcus aureus, there is comparatively little variation in the pathologic changes in infections caused by pyogenic organisms. The virulence of the organism varies and, in some instances, as illustrated by Brodie's abscess, staphylococci exist and produce osteomyelitis in a semidormant state.

Among adult patients osteomyelitis originates in any portion of bone but when the disease affects children it usually begins in the diaphysis of the long bones, especially in the femur and the tibia. Bacteria lodge in the fine capillaries or end arteries of the long bones, where toxins produce vascular engorgement, edema, leukocytic infiltration and necrosis. The infection rarely penetrates cartilage but spreads through the haversian and Volkmann's canals to the cortex and subperiosteum. It frequently cuts off the vascular supply of portions of bone and causes absorption which is associated with sequestration and subperiosteal abscesses.

Among the first symptoms of acute osteomyelitis are diffuse aching pain in the involved region, which subsequently becomes localized, tenderness, increased heat and protective muscle spasm. Such general symptoms as fever, malaise, headache, nausea and vomiting are usually present. In many cases of chronic osteomyelitis there is a persistent draining lesion which does not produce untoward effects except occasional exacerbations of pain by temporary obstruction of drainage. Although osteomyelitis may remain inactive and for a number of years may appear to have healed, there is always a potential danger of recurrence.

The early recognition of osteomyelitis is often dependent upon evaluation of the clinical history of a few vague symptoms, since localized signs or roentgenographic changes are not present during the early

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stages. Roentgenographic changes may not occur during the initial eight to ten days, but from the tenth to the fourteenth days a region of decreased density or ill defined patch will usually be visible near the epiphyseal line; definite softening and periosteal reaction occur after two to three weeks. Subsequent roentgenograms at monthly intervals may reveal thickening of the shaft, rarefaction, sequestration and involucrum as the condition progresses. The diagnosis of osteomyelitis usually is not difficult, but in some instances an exploratory operation and the removal of a specimen for microscopic and bacteriologic examination may be necessary to distinguish osteomyelitis from osteitis, periostitis, arthritis and various other inflammatory conditions or tumor. The marked similarity of hemangio-endothelioma and osteomyelitis cannot be overemphasized. This similarity has been considered by Pollock and one of us (H. W. M.) in a previous paper. The local findings, especially the roentgenographic findings, and the general symptoms, even moderate fever, may be so similar in cases of osteomyelitis and of Ewing's tumor that diagnostic irradiation or biopsy is necessary in order to distinguish between the two conditions.

One must take into consideration several factors when determining the type of treatment indicated in an individual case, namely, the duration of disease, the site and extent of the lesion, the causative organism and the general condition of the patient. There are few contraindications to the usual supportive measures such as complete rest in bed, immobilization of the affected part, the use of analgesics, sulfonamides and the abundant ingestion of fluids. There is some difference of opinion, however, regarding the advisability of surgical intervention in cases of acute osteomyelitis. Although most authors still advocate immediate incision and drainage and the instillation of petrolatum packs (Orr's method of treatment) or the use of dakinization, some believe that incision of periosteum and soft tissue abscess is preferable. The lessons gained from the first World War taught the effectiveness of

Fig. 1. Ewing's tumor of upper portion of shaft of right femur.

dakinization of infected wounds. In order to obtain successful results with this method of treatment it is essential that the patient receive meticulous care; all dressings must be changed under rigid aseptic conditions and the edges of the skin protected with petrolatum gauze.

Recent studies have revealed the increasing value of chemotherapy as an adjunct in both the conservative and the operative treatment of osteomyelitis. In the early stages of some of the indefinite inflammatory lesions and in cases of septicemia in which the infection is not localized, the immediate use of chemotherapy doubtless lessens the severity of the local and general manifestations and is a life-saving measure. Sulfanilamide and sulfathiazole, which are known as sulfonamides, should be used in the prophylaxis of severe wounds and

compound fractures, in cases of osteomyelitis in which operation is contraindicated or refused, in preoperative and postoperative

FIG. 2. *a*, chronic osteomyelitis of approximately forty years' duration. There is marked thickening of the femur with regions of sclerosis and osteoporosis and evidence of repeated operations; *b*, lateral view.

treatment and in cases in which a fulminating infection is associated with septicemia.

Sulfanilamide apparently is more effective than sulfathiazole in the treatment of infections caused by streptococci, while sulfathiazole is the drug of choice in the treatment of staphylococcic infections. These drugs are especially effective in cases in which septicemia is a complicating factor. They may be safely and effectively administered orally in the form of tablets, each containing 7½ gr. (0.5 Gm.). Ninety gr. (6 Gm.) should be administered in six doses. This amount usually will maintain a concentration of 10 mg. of the drug in each 100 cc. of blood. When higher concentrations of the drug are maintained in cases in which virulent infection does not respond well to treatment, the patients should be observed carefully for untoward symptoms. Some physicians advocate the administration of huge doses of these drugs during the first twenty-four hours, that is, until the concentration of the drug in the blood reaches 20 to 30 mg. per 100 cc., and the maintenance of this concentration for two to three days, after which the amount is decreased progressively in proportion to the progress of the patient. It is too early to evaluate definitely the efficiency of this plan of therapy. The local administration of 10 to 15 Gm. of the powdered drug is indicated as an adjunct in the treatment of open wounds. There does not appear to be any irritation of the surrounding tissues following local application of these drugs, and the amounts employed do not play a great part in the concentration of the drugs in the blood. These drugs can be injected into the sinuses or cavities when mixed with cod-liver oil; 5 Gm. of either drug is blended with 30 cc. of the oil. Either sulfanilamide or sulfathiazole can be used in a standard 0.8 per cent solution for the irrigation of wounds. There are some physicians who claim that this solution has a bacteriostatic or bacteriocidal effect. The use of this type of treatment varies according to the type of infection and the individual response to the drug used. In cases of septicemia in which treatment is adequate, the recovery rate is 70 to 75 per cent.

Sufficient time has not elapsed to permit evaluation of the types and extent of acute and chronic poisoning resulting from chemotherapy; we have encountered instances of individual hypersensitiveness to chemotherapy but not any case in which serious permanent damage occurred. Such untoward reactions as malaise, headache, nausea and vomiting, and gastrointestinal derangements are usually tolerable and may be partially prevented by inhalations of oxygen.

REPORT OF CASES

The following reports of cases illustrate the use of some of the methods of treatment that have just been described and also emphasize the difficulties encountered in the diagnosis and clinical management of some infections of bone.

EWING'S TUMOR OF THE RIGHT FEMUR

Case 1. A boy, aged nine years, was brought to the clinic on August 8, 1938, because of recurring attacks of nausea, vomiting, temperature ranging up to 102.2°F. and pain in the right thigh. The history did not disclose trauma or any other significant findings. The illness had begun fourteen months prior to the patient's admission. During this period attacks had occurred at intervals of several weeks and had lasted one to four days. A diagnosis of osteomyelitis of the right femur had been made clinically. Five months before the patient was brought to the clinic an exploratory operation had been performed, at which time the local pathologist had sent sections to a distinguished pathologist, who made a diagnosis of sclerosing osteomyelitis. Drainage had not occurred after the operation but pain and fever had persisted and three courses of roentgen therapy had been given.

Examination at the clinic disclosed a thin and undernourished patient who walked with a noticeable limp on the right and who had muscle spasm and swelling of the right thigh with limitation of motion of the right hip and knee. His temperature ranged between 99° and 100°F. The roentgenograms of the thorax gave negative results. There was considerable variation of opinion regarding the diagnostic significance of the roentgenograms of the right femur. The roentgenologist said, "This case brings up the perennial question of inflammation versus neoplasm." One of us (H. W. M.) expressed the opinion that the roentgenologic appearance was strongly suggestive of Ewing's tumor and advised against further operation but suggested irradiation as a diagnostic and therapeutic measure. Four courses of irradiation consisting of four treatments each were employed over a period of three months.

Fig. 3. *a*, region of periostitis with region of decreased and increased density in shaft of right femur; *b*, lateral view; *c*, anteroposterior view showing abscessed cavity with tube inserted and operative window; *d*, lateral view similar to *c* showing window through cast.

When the patient was re-examined at the clinic on December 6, 1938, râles had developed in the thorax and roentgenologic examination disclosed metastatic involvement of the lungs. This was four months after his first consultation at the clinic and nine months after surgical exploration elsewhere. The patient continued to fail and died at home on February 12, 1939, about twenty-one months from the onset of his symptoms.

Necropsy disclosed an extensive primary Ewing's tumor (hemangio-endothelioma) of the right femur (fig. 1) and metastatic involvement of the lungs, pleura, pelvis, ribs and skull.

Comment. This case illustrates the difficulty encountered in distinguishing inflammatory lesions of bone from neoplasms.

Fig. 4. Six and a half months after onset of extensive osteomyelitis of left radius with sequestration.

The cortical thickening, the extensiveness of the involvement and the periosteal lamination were suggestive of Ewing's tumor but osteomyelitis could not be excluded. Tissue removed in cases of Ewing's tumor has been diagnosed frequently as inflammatory. Irradiation causes marked regression of the local growth, an effect so typical as to lead to employment of the treatment as a diagnostic procedure; hence the term, "diagnostic irradiation."

OSTEOMYELITIS OF FORTY YEARS' DURATION

Case II. A man, fifty-one years of age, formerly a patient at the clinic, returned for examination on June 27, 1941, because of pain in his right leg associated with a pulsating sinus which was discharging foul-smelling fluid. Since the onset of his trouble in 1916, approximately twenty-six years previously, this patient had had, at the clinic and elsewhere, numerous operations, among them curettage and sequestrectomy, and various forms of treatment, including treatment with maggots. Cultures had been made at various times and had showed staphylococci and streptococci. One of us (H. W. M.) had advised the patient on several occasions to have amputation because of the chronicity, stiffness of the knee, pain, foul-smelling discharge and the possibility of malignant disease, but he had refused.

Examination of the patient in June, 1941, disclosed that he was extremely ill, toxemic and feverish. Chemotherapy was instituted and on June 27, we performed amputation through the junction of the middle and lower thirds of the right femur. The soft tissues of the leg were a firm mass of scar tissue and the femur was several times its normal thickness as a result of chronic osteomyelitis. (Fig. 2A and B.) The patient's health improved after the amputation and at the time this report was written he had gained in weight, had complete relief from pain and the stump was healed.

Comment. One of us (H. W. M.) followed this case over a period of many years and from time to time was consulted by the patient because of the foul discharge, pain, fever and disability. He found it possible to control the odor by irrigations of Dakin's solution. The sinal cavity was so large and the disease so extensive that conservative surgical intervention was of little value and the repeated operations which the patient underwent served only to provide more adequate drainage. Amputation was the final choice and was resorted to only after prolonged illness, loss of function of the knee joint, disability and toxemia.

In this case, because of the prolonged irritation at the point of drainage the possibility of malignant disease was considered

but careful examination by a pathologist at the clinic failed to show any evidence of it. Since chronic osteomyelitis with prolonged drainage is rare, our experience with such cases is limited, but we have noted that malignant disease develops in cases of infection of bone associated with prolonged drainage; it occurs along the edge of the sinus and usually, when a specimen is removed for microscopic examination, is found to be epithelioma.

Case III. A man, aged twenty-nine years, reported for examination at the clinic on October 1, 1940, at which time he complained of pain about the right knee of one month's duration. At the age of ten years he had had osteomyelitis of the left tibia which had completely healed. Thereafter he had been in normal health until, five weeks prior to registration, he had injured his right knee. Pain about the knee had begun one week after the injury was received, had been continuous, worse during the night, and had progressed in severity despite treatment. The physician in the home locality had considered a diagnosis of neuritis and two teeth which he believed were possibly foci of infection had been extracted. Because the patient's temperature had risen to 103°F. he had been hospitalized and had received 90 gr. (6 Gm.) of sulfanilamide daily for five days. At the end of this time roentgenographic examination, which previously had given negative results, revealed a region of decreased density in the femoral shaft, and the patient came to the clinic for consideration of surgical intervention.

Examination revealed evidence of local heat, swelling, tenderness and limitation of motion of the right knee. The temperature and the leukocyte count were normal. The sedimentation rate was 107 mm. per hour. The pain became more severe, the leukocyte count increased to 15,700 per c.mm. of blood, the temperature ranged from 100.5° to 102°F. and at the same time the roentgenograms definitely revealed osteomyelitis of the lower portion of the right femur. (Fig. 3A, B, C and D.) It was evident that chemotherapy had not checked the osteomyelitic process. The pain, temperature and increasing leukocyte count were signs that the infection was still active and that drainage was indicated.

At operation considerable thick purulent material was obtained and sent for culture. Sulfanilamide powder and drains were inserted into the wound. Figure 3C and D reveals the postoperative appearance of the femur with drainage tubes in place. The patient was dismissed eight weeks after operation, at which time the wound was practically healed.

Fig. 5. Anteroposterior view three months after onset of acute osteomyelitis of right tibia which was treated by drainage and chemotherapy.

The bacteriologic examination of the material removed at the time of the operation did not reveal any growth of organisms. The sterile cultures were of particular interest in that the patient had received a course of sulfanilamide prior to operation.

On August 12, 1941, ten months later, when one of us (H. W. M.) saw the patient he had

full motion of the knee, the wound was healed and he was not experiencing difficulty.

Case iv. A girl, aged eleven years, was examined at the clinic on September 7, 1939, because of severe pain of four days' duration in the left wrist. One week prior to her admission a furuncle of the right buttock had been noticed; this lesion drained spontaneously five days later. Three days prior to her admission the patient had sprained the left wrist; on the following day pain had developed in the wrist and within forty-eight hours the girl's temperature had risen to 105°F. She vomited frequently, became irrational and semicomatose and was sent by ambulance directly to the clinic from a neighboring state for emergency treatment.

Fig. 6. Two months after onset of osteomyelitis of right tibia. Note involvement of entire diaphysis with regions of increased density and periosteal proliferation but no definite sequestra.

Examination revealed an acutely ill and delirious young girl who had swelling and tenderness of the left wrist and diffuse infection of the left forearm. At the time of her admission her temperature was 104°F., the pulse rate 94 beats per minute and the leukocyte count 16,900 per c.mm. of blood. The leukocyte count increased to a level of 40,600 per c.mm. on the fifth day, at which time cultures of material from the furuncle of the buttock and of the blood were positive for Staphylococcus aureus. The patient received 60 gr. (4 Gm.) of sulfapyridine daily, an amount that maintained a concentration of 3.3 mg. of the drug in each 100 cc. of blood. Two days later through-and-through drainage of the forearm was instituted surgically, and cultures again revealed Staphylococcus aureus. Fluid was not obtained from lumbar puncture repeated several times. Roentgenograms taken during the first three weeks were negative but those taken October 16, showed extensive osteomyelitis of the shaft of the radius and destructive arthritis of the radiocarpal joint. Convalescence in the hospital was stormy and during this time several sequestra sloughed from the forearm. The patient's mother wrote us on February 14, 1941, however, that the arm had continued to heal and drained only occasionally. (Fig. 4.)

Comment. This case is a classical illustration of acute osteomyelitis and staphylococcic septicemia complicating a staphylococcic infection of the buttock. Chemotherapy in this case perhaps would have been more effective had a higher concentration of the drug in the blood been maintained during the acute stage of the disease. Had sulfathizaole been in use at that time, it would have been administered. Although the question of the advisability of surgical drainage in acute osteomyelitis in the presence of fulminating staphylococcic septicemia is debatable, we believe that under such circumstances drainage of a formed abscess is indicated, as the abscess is a possible focus of infection for an indefinite length of time. Treatment with sulfonamides, in our opinion, has proved

revolutionary in the management of such cases.

Case v. A woman, aged forty-two years, was admitted on December 29, 1937, at which time she stated that she had been in normal health until one week prior to admission, when a wisdom tooth had been extracted. She further stated that twelve hours later pain had developed in her right knee and had become progressively more severe, that her temperature had ranged up to 104°F., and that on the third day she had had also intense aching pain in the left arm, sternum and back. A slightly productive cough had been noted.

Examination of this patient revealed tenderness and swelling of the right knee, a temperature of 102.6°F., a leukocyte count of 13,000 per c.mm. of blood, many carious teeth and a wound of the jaw from the recent dental extraction. The patient was hospitalized and 60 gr. (4 Gm.) of sulfanilamide were given daily for eighteen days during which time a concentration of 3 mg. of the drug per 100 cc. of blood was maintained. The roentgenograms of the right lower extremity taken during the first two weeks were negative; those next taken revealed definite rarefaction in the shaft of the right femur. Several blood cultures made during the first two weeks of hospitalization were reported as negative, but subsequent to exploration of the lower third of the right femur on January 12, 1938, Staphylococcus aureus was found in cultures of the blood and of the material from the wound. The convalescence was stormy and despite all available medical aid, including six transfusions of blood and chemotherapy, there was a gradual downhill course until death occurred on the eighth day after operation, or the twenty-sixth day after extraction of the wisdom tooth.

Comment. It is possible that maintenance of a higher concentration of sulfanilamide in the blood might have been more effective; with our present knowledge of chemotherapy we would recommend sulfathiazole in large doses. Fortunately, such fatal complications as occurred in this case are becoming comparatively rare as knowledge of chemotherapy advances.

The following two reports of cases are added to illustrate advancement in the use of chemotherapy.

Case vi. A boy, aged nine years, was examined at the clinic on May 7, 1941, at which time he complained of pain, swelling and redness of the right leg of five weeks' duration. The illness had begun spontaneously and had first been treated as rheumatism by the family physician. There had been progression of the symptoms accompanied by high fever. Although sulfanilamide had been administered for seven days, on the tenth day there was copious purulent drainage from the medial aspect of the lower third of the right leg. Roentgenograms at that time revealed osteomyelitis and the patient was brought to the clinic.

Examination of the patient revealed a thin, pale boy who had draining osteomyelitis of the right tibia. The temperature was 100.5°F., the pulse rate 105 beats per minute, and the respirations were 25 per minute. The concentration of hemoglobin and the erythrocyte count were somewhat decreased and the leukocyte count was 11,400 per c.mm. of blood. The results of urinalysis, roentgenograms of the chest and a flocculation test were normal. Bacteriologic examination of material obtained from the draining wound revealed Staphylococcus aureus.

The patient was hospitalized at once where he received 60 gr. (4 Gm.) of sulfathiazole orally each day for six days. The roentgenograms at that time revealed extensive involvement of the entire right tibia but clinically there was marked improvement in the boy's condition. On May 12, 1941, with the patient under general anesthesia the wound was enlarged and through-and-through drainage established. A few days later the boy was permitted to return home under the care of his family physician.

Examination at the clinic three months later revealed the presence of some serous drainage; the patient's general condition was much improved and roentgenograms disclosed extensive involvement of the entire shaft of the tibia without definite sequestration.

Comment. We believe that the course of the osteomyelitis of the tibia in this case was greatly influenced by the institution of chemotherapy, proof lying in the improvement shown, in the lack of extensive sequestration and in the type and amount of drainage. (Fig. 5.)

Case VII. A girl, aged eleven years, was examined at the clinic on June 12, 1941, at which time she complained of pain about the right ankle joint. Eight days prior to her admission the patient had turned her ankle and the local physician had taken roentgenograms which proved to be negative. A cast had been applied to the right leg but had been removed five days later because the leg had become red and swollen and the patient's temperature had increased to 102.5°F. Forty gr. (2.6 Gm.) of sulfanilamide had been given to the patient and she had been referred to the clinic.

Examination revealed a temperature of 99.4°F., a pulse rate of 100 beats per minute, and marked heat, tenderness and swelling of the right leg. Roentgenograms were indeterminate; a clinical diagnosis of osteomyelitis was made and the patient hospitalized. Seventy-five gr. (5 Gm.) of sulfathiazole were administered daily for a period of eleven days. Clinically, there was definite improvement in the girl's condition but a temperature of 99° to 101°F. persisted. Roentgenograms at that time revealed typical osteomyelitic destruction of the distal end of the diaphysis of the right tibia. The patient was dismissed to the care of her physician at home with the advice to take 60 gr. (4 Gm.) of sulfathiazole daily and to report back to the clinic in one week.

Subsequent examinations revealed continued improvement in this patient's condition and chemotherapy was discontinued August 8, 1941, after which efforts to build up her general resistance were begun. Roentgenograms eight weeks after the onset of the condition revealed involucrum but no sequestration. (Fig. 6.) The reaction disclosed by the roentgenograms was decidedly less in extent than that which we have observed in cases in which chemotherapy has not been used.

Comment. This case illustrates the improved results obtained from adequate chemotherapy in cases of acute osteomyelitis. It is our opinion that sulfathiazole was effective in the prevention of extensive destruction of bone with sequestration, which is the usual complication in such cases.

SUMMARY AND CONCLUSIONS

Chemotherapy orally and locally is indicated in osteomyelitis complicating fractures. Chronic osteomyelitis of a low degree of virulence may be in existence over long periods of time, may go unrecognized, and usually is diagnosed as arthritis. In the majority of instances roentgenograms will reveal localized circular or oval areas of decreased density. Furthermore, the nonsuppurative sclerosing type of osteomyelitis (Garre's type) is characterized by a region of localized increased density of bone with thickening of the cortex and medulla, and is accompanied by persistent pain which is worse at night; the leukocyte count is not increased and localized heat may or may not be present.

We believe that sulfonamides have proved of inestimable value in the treatment of septicemia and acute osteomyelitis. Blood cultures taken before localization of the lesion of the bone and adequate chemotherapy may prevent osteomyelitis and its complications and septicemia with fatal results. When large abscesses have formed, it is our opinion still that adequate surgical drainage of the infected region is indicated.

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END RESULTS OF SCREW FIXATION IN INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR

T. Turner Thomas, M.D.
PHILADELPHIA, PENNSYLVANIA

IN our opinion the old classification of fractures of the femoral neck into the extracapsular and intracapsular remains the best. The intracapsular is for us decidedly the more important of the two. This is because of our failures to obtain bony union of the fragments except by screw fixation.

EXTRACAPSULAR FRACTURES

While these fractures are probably if not in all cases partly intracapsular anteriorly, they are essentially extracapsular because the joint is invaded if at all very close to the anterior intertrochanteric line, which is the lowest limit of the capsule and synovial cavity. In other words, the fracture line passes through the base of the neck, which is largely made up of cancellous bone; so that the fragments present wide fractured surfaces, usually with good approximation and a capacity for much callus formation, so that good union occurs almost always. The opposite is true of the intracapsular fracture, the small head fragment of which has a much poorer blood supply coming only through the ligamentum teres. That of the extracapsular fracture gets as much blood from the ligamentum teres, and in addition has much more ligamentous and muscular attachments through which to receive additional blood supply. The callus and other resulting reparative material developed, probably fill up the small part of the joint involved and wall off the fracture from the joint, so that it presents a much less troublesome problem than the intracapsular fracture. I cannot recall nonunion in an extracapsular fracture. In my experience the Whitman abduction cast applied early has almost always produced a well nigh perfect reduction and close approximation of the fragments, with resulting firm bony union and excellent function, so that we feel little concern about the prognosis in these cases.

INTRACAPSULAR FRACTURES

Of all common fractures of the extremities these have been the most formidable from the standpoint of providing a good prognosis. In recent years they have received much attention and have made much progress in the results obtained. I have been interested in fractures for forty years with a very limited early personal experience and only a moderate one since. This discussion will be limited almost exclusively to personal experience since 1918, and will deal almost entirely with the methods used and the results obtained with screw fixation of the fragments. It is believed the best presentation can be made by cases selected because of their particular importance in emphasizing the essential facts.

My particular interest in intracapsular fractures has been largely influenced by a case in a sixty-year old man, who was admitted to the Northeastern Hospital May 10, 1920, four weeks after his accident. An amputation had been done at the middle of the opposite thigh years before. He was a maker of fine instruments but needed one good lower limb in order to follow his occupation with the support of a crutch. I did not have enough confidence in the Whitman abduction cast to rely on it for bony union in this case after a four weeks' delay elsewhere in beginning treatment.

Delbet had passed a screw through both fragments without arthrotomy, but I could not then find a satisfactory description of

his method of introducing the screw. He depended upon traction for the correction of the displacement of the fragments and a specially devised apparatus for accurate placing of the screw. If I had found a satisfying description of the method I could not have obtained the instrument in time for use in my case, so that I was compelled to abandon the method or quickly develop another. This method devised for screw fixation for this case has been employed in every other patient operated upon since, consequently, I cannot discuss any other operation for the condition. It was reported before* with the results in four cases. All the patients were operated upon from four weeks to four months after the accident and all had excellent functional results, particularly in view of the delay in each one. The first and only failure to obtain union by the method will be discussed later.

That the methods without arthrotomy and exposure of the fragments have had a strong appeal, is evidenced by the variations in the methods attempted. It could not be otherwise with so radical a departure from the established procedure for applying internal fixation of a fracture, particularly one within a joint and more particularly a joint so difficult to expose. But if it can be done more safely than by the direct exposure, in all probability it will be done more frequently with increasing efforts to improve the method and with a consequent delay of standardization. There are too many problems to be settled, too many questions to be answered. We are content to follow our own method until convinced another is better. A better one must be safer and produce a better result. Ease of performance can afford to wait.

When the need of devising it arose unexpectedly, the most trusted method for obtaining bony union was the Whitman abduction cast. According to our experience, it was then and is now the only method of reducing the deformity without traction almost if not perfectly every time, which it will continue to maintain until the cast is removed. We know of no other method which will do this except the Whitman, around which the screw fixation was devised. If for any reason we were deprived of this advantage, the method would be abandoned. There was only one way of retaining it. It became necessary to operate through an opening in the cast. To the objection that one could not provide enough room for performing the operation, the reply is that it has never been done by us in any other way; and to the objection that it exposes the patient to the danger of infection, the answer is that no evidence of infection can be recalled in any case, not even a stitch infection. That the *x*-ray taken after the drying of the cast would show the position of the fragments until the cast was removed, was vital to the safe placing of the screw. One other requirement was essential, namely, provide before the operation sterilized screws of the proper length and caliber. It will be too late to select and sterilize others during the operation. We think it would be impractical to provide a sufficient number of specially devised screws to meet any emergency in this operation. There will be too great a variety of requirements in length and caliber in the different sizes of patients. The method necessitates having ready at the moment of need, the necessary number of any desired screw. If these requirements could not be provided, it would be necessary to abandon the operation. We think it can be done only with the common carpenter screws, which are made of steel can be sterilized as thoroughly as the best special screws made. That is all that matters in connection with this operation or any other fracture we can recall, except those in which special plates and screws were employed. We have used few or none of these for years. Of the common screws one can obtain any number, length or caliber at almost any time in almost any town. Without these screws the operation becomes impractical, but we have been using them for more than twenty years and can recall no cause for regretting it. The operation

*Am. J. Surg., p. 292, September, 1921.

requires it and we prefer the operation to any other with a special screw, at least in such operations as these. Without ever regretting it, we employed the common screws and nails in other fractures before doing so in those of the femoral neck.

Having decided the approximate length of screw desired from the *x*-ray film, with the necessary correction for the enlargement produced by the *x*-ray and the desired caliber, enough are selected of the correct length and caliber. At least the next lengths above and below are selected and several calibers of each. The one or two used must cross the fracture line sufficiently to grasp the small fragment firmly but not pass through the head into the joint or acetabulum. The screws must be selected and prepared so that they will work successfully when introduced; for if they fail as already stated, it will be too late to select and prepare new ones.

Method of Screw Fixation. A Whitman abduction cast is applied in the usual manner without inclusion of the opposite limb. An opening is made in it over the great trochanter with an old Bard-Parker knife blade while the cast is still soft, about nine inches long and about six inches wide, with the trochanter about in the center. The operation is done through this cast opening; because it is the only method available for utilizing the guarantee of the cast for perfect reduction and fixation of the fragments until the screws are introduced and union established. Just as we have banished the fear of too much traction in the use of the traction cast, so we have banished the fear of infection in these cases. It could happen but never has in the twenty years of our use of the method. Why let that fear deprive us of the advantages of the operation?

A few years before our first screw fixation in these cases, we adopted open reduction and internal fixation for most shaft fractures of the lower extremity, because of our failure to accomplish satisfactory reduction by the closed method. We then became interested in the practice of an other surgeon in similar operations. He swabbed the wound before closure with dichloramine-T with the purpose of destroying or discouraging the growth of any bacteria that might have survived the preparation of the field of operation or gained admission to the wound during the operation. Without knowing how much if any bactericidal value it has we have not yet discontinued the practice, although we have substituted for the dichloramine-T a 2 per cent tincture of iodine followed by alcohol. We think these two, along with the perfect continuous immobilization of the fragments and a simple straight incision to the bone with almost no dissection of the tissues, will have much influence in preventing infection.

Instruments and Screws. The only instruments are those necessary for an ordinary six-inch incision over the great trochanter to the bone, which need be exposed only enough over the trochanter and the shaft of the femur a few inches lower to feel the surface for the introduction of the screws. We are not anxious to expose the bone widely to see all parts of the bone in this area. Several metal screw drivers, retractors, hemostats, catgut, etc., and other necessary material for such an operation must be available as usual. The screws must be of the desired length to grasp the head fragment firmly without going in too far. The length is determined by the distance on the *x*-ray film from the external surface of the bone, about a half inch below the well defined lower border of the great trochanter, which can be easily felt and seen in the wound and more easily in the *x*-ray film, to within about a half inch of the most prominent articular surface of the head. This distance could vary with the degree of rotation of the femur during the application of the cast. This length is then reduced a half or five-eighths of an inch to compensate for the *x*-ray enlargement of the head. If the limb is always held in forced internal rotation as usual in the application of the cast, this variation will

be slight and the plane of the path of the screw will be almost if not completely horizontal, which is most easily followed in imagination for the blind introduction of the screw.

Two screws of the selected length are usually introduced. The others prepared vary in their lengths and calibers above and below the length and caliber selected. These additional screws are considered the most favorable for substitution if the *x*-ray taken during the operation indicates a faulty length, i.e., too long or too short. We prepare several of the length selected and likewise several of each length above and below that. In the same manner several calibers of each length above that of the first introduced, will be necessary if the first must be removed, because the substitute screw must always be larger than the one removed in order that it may take a firm hold on the surrounding bone. This is the most complicated feature of the operation but we have not yet been able to simplify it. The screw must take a firm grip on the bone which the first introduced always does; but if it were removed, a substitute of the same caliber would not take a firm grip. There must, therefore, be ready larger calibers of every length screw in the collection. Substitutions are rare but they are sometimes necessary. We cannot recall a case in which the desired length and caliber were not ready when needed. But the preparation necessary to provide these various lengths and calibers is always an anxious task.

Cleansing and Draping of Field of Operation. Since we had no knowledge that such an operation had ever been done through a cast opening, protection from infection of the wound became a major responsibility. The following technic was devised and has been used in every case:

The surgeon gowned and gloved as for any sterile operation, grasps a sterile gauze pad, wet with ether, by a sterile forceps as long as available. While standing far enough away from the patient and operating table to protect his sterile gown and gloves from contact, he thoroughly rubs the exposed skin with ether after which he discards the forceps. By carefully holding a sterile towel in front of him by its upper edge with one hand, he raises it above, free of the cast opening. At the same time he grasps the surface of the towel toward him with another long forceps near the free end, about two inches or less above its lower border. He pushes the same end under the upper edge of the cast opening at its corresponding end, without permitting the forceps or the surface of the towel to become infected. In this way he continues to tuck the successive portions of the towel edge under the continuing cast edge as far as it will reach. Then the opposite side of the towel is laid on the underlying cast surface. This portion of the skin is thus protected from infection. Taking hold of another sterile towel in the same manner, he pushes its free end under the end of the first towel and cast margin. He continues the tucking of it under the cast margin until the exposed skin surface is completely isolated from the underlying unclean cast.

The exposed skin is next swabbed with tincture of iodine followed by alcohol. After this the large sterile sheets are laid over the patient and table, the margins being pushed under the cast margin of the opening where they correspond to it and the previously laid sterile towels. (Fig. 1.) The crowding of sheet and towel under the cast may require force but it adds to the protection of the exposed skin. The manipulation of the first laid towels requires some care and skill but has been done in all of our cases without infection of the wound in any case. It is justified by the results of the operation.

Operation. The surgeon now palpates the great trochanter around which the opening in the cast was made and finds it about in the center. He makes a longitudinal incision five or six inches long over it, from its upper palpable margin downward through the skin and subcutaneous tissue. Sterile towels are then clamped to the margins of the incision, further protecting

the wound from infection. The incision is deepened to the bone in its whole length and particularly below the lower prominent margin of the trochanter, which is the most valuable landmark for directing the screw. The bone here is cleared in an area a few inches in all directions. The screws are to be introduced, the first about a half inch below this prominent margin, the second below the first far enough to prevent the large head from overlapping any part of the head of the first screw. This overlapping would prevent the removal of the first if necessary, without removing the second. The *x*-ray taken during the operation might show either or both in faulty position. Proper spacing between them would permit either to be removed without disturbing the other.

Placing of Screws. All that remains to be done is to place the screw properly, close the wound and apply the dressings. But the operation is to place the screw without exposing the fragments, the avoidance of which justifies all of the details and care necessary for doing it safely and effectively. But we have little or no concern about this phase of the operation. We are concerned only with the difficulty of making the technic simple and safe to others.

With the femur in forced internal rotation in the Whitman abduction cast, its neck is almost if not quite in the horizontal plane. With good retraction of the wound, one can hardly get a good view of the femur immediately below the trochanter, where the screw is to be introduced. But one can readily locate the surface of the trochanter with his fingers, the hollow space below it indicating the beginning of the shaft of the femur. He can push his finger anteriorly close to the trochanter and recognize the beginning of the neck, which will aid in directing the screw along the neck. By straining I have felt the head of the femur but do not think it necessary for safe introduction of the screw. This finger exploration for the beginning of the neck from the trochanter was not used in the early cases but was continued after trying it. It was found safe and helpful.

Here begin the details and difficulties of placing the screw, which have been justified by the results. With the femur in forced internal rotation in the Whitman cast, we know that the neck is almost if not exactly in the horizontal plane. With strong retraction of the wound margins, the point of the selected screw is placed against the outer surface of the femur, about a half inch below the easily located lower margin of the trochanter. With the *x*-ray film of the reduced and abducted fragments and the surrounding skeleton in the Whitman cast favorably placed in full view for guidance, and with the left forefinger lying on the neck in the channel previously made by the finger, the angle of the neck with the shaft of the femur and the trochanter can be readily plotted in the mind. Then it should not be difficult to direct the screw safely to its destination.

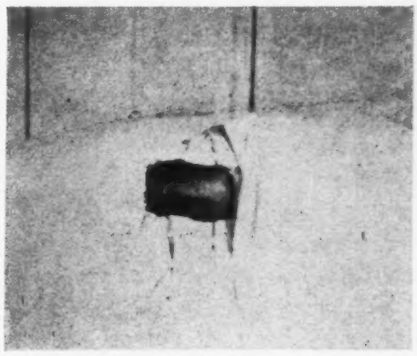


Fig. 1. The hole cut in the cast is here shown draped and ready for the making of the incision and introduction of the screws.

After the left forefinger has determined the direction of the neck, it is removed and used with the thumb to place the point of the screw in position at its selected site of entrance below the trochanter and to hold it there, directed as well as possible in the line of the neck. It is then started on its course by a metal hammer in the right hand, far enough to be held and directed by the left hand more easily. After this it is forced inward by a large screw driver while the left forefinger is again placed on the

neck in the channel previously made, the effort being to keep the course of the screw as nearly as possible in the desired direction through both fragments. A second similar screw is usually introduced in the same direction, far enough below the first one to avoid contact with it and particularly to prevent the head of the second from overlapping the head of the first, which would prevent the removal of the first for any reason without the other.

Formerly, this concluded the operation, except to close the wound and apply the dressings. But an *x*-ray was taken on the following day. If one screw or both were not satisfactorily placed, the wound was reopened and the position of the screw was changed. But it was decided to try covering the wound with sterile towels and the whole table and the patient with sterile sheets before closing it for the immediate taking of an *x*-ray. This practice has been continued since. If the positions of the screws are shown to be satisfactory by the *x*-ray, the protecting covering sheets and towels are removed. The gowns and gloves are renewed by the surgeons and the operation concluded. Both screws are then forced in as far as possible for better approximation and fixation of the fragments. The wound surface is swabbed with a 2 per cent tincture of iodine followed by alcohol. The wound is closed by a continuous chromic catgut suture of the divided tensor vagina femoris muscle, its aponeurotic expansion, and interrupted silk sutures of the skin. Sterile gauze moist with alcohol is applied to the wound, with additional dry gauze sufficient to fill the cast opening somewhat higher than the cast surface. This permits firm compression of the wound by enough adhesive plaster strips, long enough to secure this compression and prevent movement of the dressings afterward.

Associated Problems. Infection has not been a problem because we have had none. Nor is nonunion a problem, except that in one case after two years union was considered still absent. This case will be reconsidered later.

Excess Length and Deviation of Screws. We have no knowledge that this problem has arisen in connection with the use of any specially devised screws, those most commonly employed being connected with the fixation of fractures by plates and screws, which are usually all made of the same length for each method as for the Lane and Sherman plates. But the screws used in intracapsular fractures of the neck of the femur may not be made of one length, for the length necessary will vary with the individual case. A screw of uniform length, whatever the length selected, would frequently if not usually go too far in or not far enough. The screw must go through the distal or outer fragment but must not go through the proximal or head fragment, except just far enough to take a firm hold of it without encroachment on the articulation. Since the length of each fragment varies and their combined length varies or may vary in each case, it would be impossible to be sure of having ready any specially made screw of the right length when needed in the operation. Only the common carpenter screw can be used successfully and has been by us without exception for this method of screw fixation of this fracture. It would be necessary to abandon this method without it.

In a few cases when one screw was well placed and the other not, the former was retained and the latter removed. But as experience increased, the tendency grew to reintroduce the screw in better position. If it were too long and its direction good, a shorter screw of larger caliber was substituted to insure a firm grip on the bone. A loose screw or nail is always dreaded in any fracture.

CASE REPORTS

Complete Failure of Screw Fixation from Faulty Use of Whitman Abduction Cast. From the following case developed the conviction that there is an inherent weakness in the Whitman abduction treatment for intracapsular fractures of the neck of

the femur, which we had not previously suspected:

The patient, a middle-aged man, was admitted to another hospital with this type of fracture. A Whitman abduction cast was applied, according to his family physician. The patient reported that it was removed after seven weeks and then he was sent home. His physician was called because of pain in the affected joint and soon afterward had the patient admitted to the Northeastern Hospital, where an *x*-ray showed an intracapsular fracture of the neck of the femur with the usual typical deformity. Suspecting a refracture because of imperfect union and too early adduction of the limb after seven weeks immobilization in abduction, he was again put in a Whitman abduction cast and another *x*-ray taken, which showed an almost perfect reduction.

It was assumed that such a reduction could not have been accomplished if the head fragment had not become so adherent in the acetabulum, during the seven weeks' immobilization in abduction, that it could not be turned with the main or shaft fragment when it was brought to the adducted position. This would explain why, when the limb was brought back to the abducted position and a cast applied, the freshly fractured surface came into perfect reduction again. Two screws were now well introduced through the usual opening in the cast. There was no disturbance in the healing, the cast being removed after nine weeks. This was considered sufficient immobilization with screw fixation of the fragments. Since no disturbance in the rotation of the head had been suspected in patients so operated upon previously, none was expected in this case. The screws were relied on to turn the head. The patient was soon afterward sent home to remain in bed and be cared for by his physician, since it was thought that the screws could be depended upon to turn the head into adduction as usual. But the patient continued to complain of pain in the affected hip. Sometime later his physician reported that a sinus developed. The patient declined to return to the hospital and no further treatment of the fracture was attempted.

No such disturbance occurred in any previous or later cases. Firm union and good but not perfect function occurred in every other case. But in most of them there was some limp. In probably every case an almost if not complete perfect reduction of the deformity was accomplished by the Whitman cast. But also in probably every case up to this period and for some time afterward, the normal angle of the neck with the shaft of the femur was gradually converted into a varying degree of coxa vara, i.e., an approximation to a right angle, which was assumed to be responsible for the varying degree of lameness. It had been thought also that this was due to weight-bearing on a femoral neck lacking normal firmness in the union between the well nourished outer fragment and poorly nourished head fragment because of its more limited blood supply. But following the refracture in this case, the suspicion grew into a conviction that the underlying cause of the refracture and the usual coxa vara was the same, namely, that during the period of immobilization of the intracapsular fragment by the Whitman abduction cast the reparative material within the joint capsule, callus and other exudate, had "frozen" the head fragment by adhesions to the capsule and acetabulum in the abducted position. This was immobilized so firmly that after the removal of the cast and the beginning of the efforts to bring the abducted limb into adduction, the small "frozen" head fragment could not be turned without undue straining and bending at its weak union with the main or shaft fragment. We believe that the addition of firm screw fixation will add enough support to turn the head fragment after eight or nine weeks' immobilization in abduction; but not without some bending of the neck, which is a big improvement on the nonunion which the screw fixation has overcome in almost all of our cases in which it has been employed.

But in this case the intracapsular fragment had remained in continuous immobilization in full abduction for some sixteen or seventeen weeks, when the adhesions had become so firm that the screws could not turn the head into adduction but cut their

way through the bone in their efforts to do so. Thus they caused the necrosis and sinus formation. This was not due to infection. of the screws had penetrated the acetabulum slightly. It could not be removed for a long time because the patient delayed giving consent.

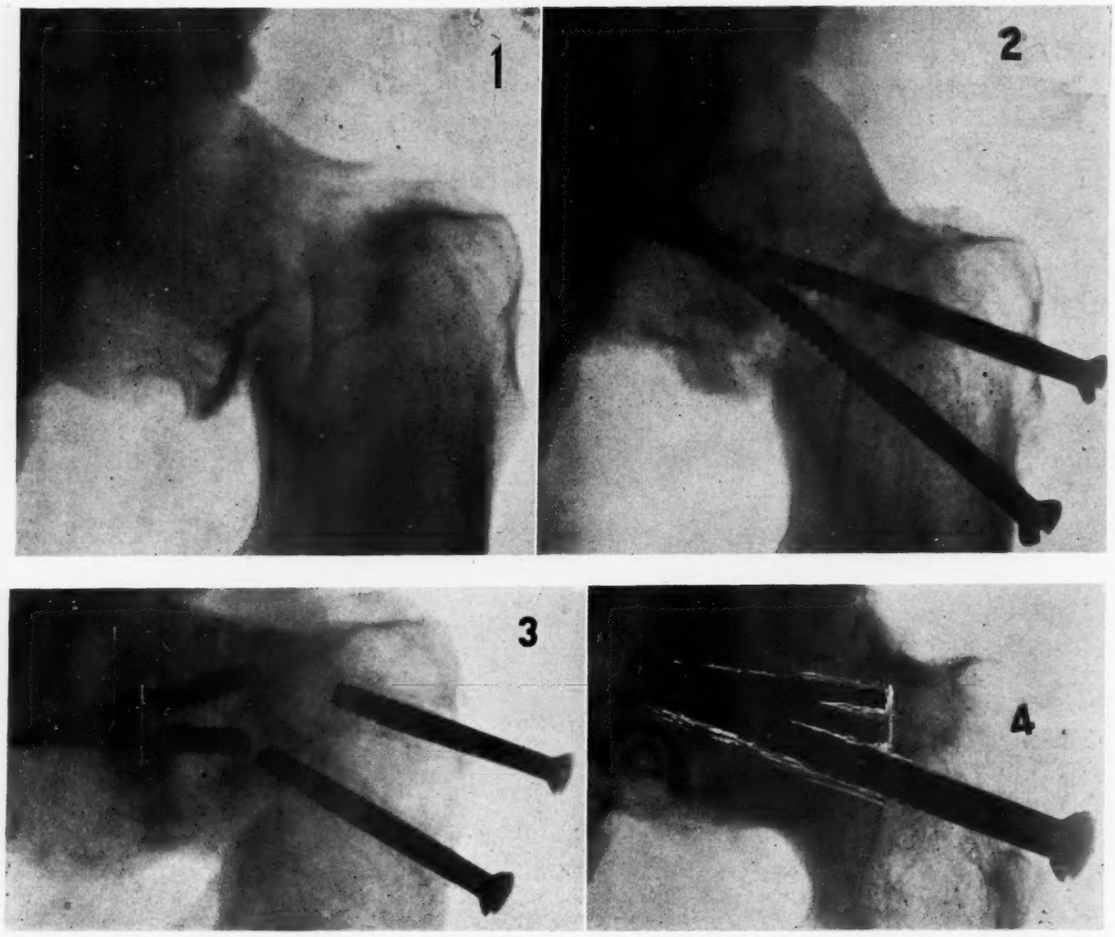


Fig. 2. Postoperative refracture of neck and both screws. 1, original deformity; 2, after first screw fixation; 3, after refracture; 4, three years after second screw fixation showing firm union, retained broken screws and new larger screw.

As a result of these considerations in later cases the cast was removed in about ten days after operation. The skin sutures were also removed, the limb being adducted before the adhesions could offer serious resistance and a new cast applied in adduction. This case completely ended our reliance on the Whitman abduction cast alone for obtaining satisfactory bony union for weight-bearing. But it is essential for our method of screw fixation.

Refracture of Neck with Two Screws. For the first introduction, November 26, 1932, in a very strong, young, laboring man the screws were permitted to project from the bone more than usual because in the preceding similar case one When removed the head of the screw was exposed with difficulty because it was covered by what appeared to be a callus formation. The heads of both screws in this refracture case were permitted to project from the bone more than usual to provide against such a difficulty. But the projection of the screws resulted in failure to bring the fragments together firmly. (Fig. 2, Part 2.) The forcing-in of the screws as far as possible had always been done previously and has been done in all cases since. In this 1932 case it was then believed that callus would fill the gap between the fragments resulting from failure to force the screws in, and that firm union would be brought about after a sufficient period. The patient was later included in a group of five similar cases in which moving pictures were taken. It proved

in his case to be a satisfactory functional result until eight months and eighteen days after the accident without interruption. He was then considered to have the best result even though he had been back at his old hard-working occupation.

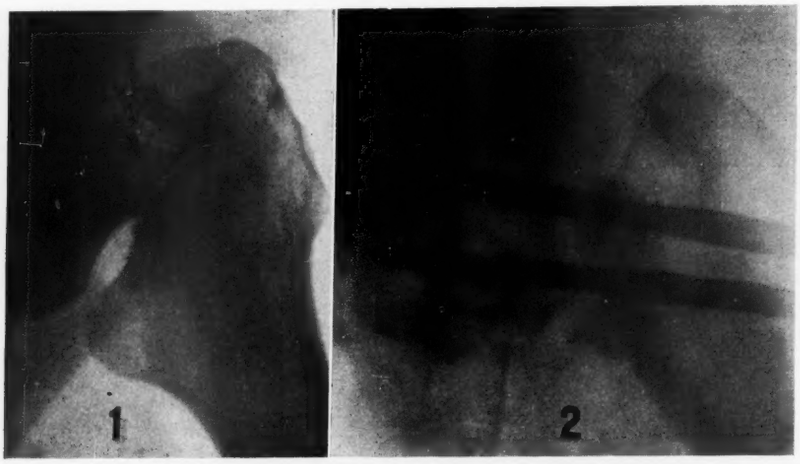
After the usual period necessary for sufficient recovery of function, he had returned to his previous occupation and had reported no disturbance until readmitted to the hospital August 13, 1933, eight months and eighteen days after the accident, with an injury to the same hip region from a fall at his work. The *x*-ray showed a refracture at the old site with both screws broken. (Fig. 2, Part 3.) A Whitman abduction cast was applied and a new *x*-ray showed the fragments returned to their normal positions. Another incision was made through a hole in this new cast and the only removable portions of both screws, those external to the fracture line, were removed. A new stronger screw was substituted, its pointed end being turned away from the retained portions of the old screws, which could not be removed. There was no disturbance of the wound afterward and after the usual period the cast was removed. The patient was advised not to return to work for a prolonged period. But he did not return for advice before going back to work until asked to do so for the taking of another *x*-ray picture, October, 1936. (Fig. 2, Part 4.)

The decision to introduce another screw in the femoral neck fracture was reached for the following reasons: If this had not been done, the patient would have been very seriously crippled for life. If infection had resulted from the operation, he would probably have been more seriously crippled; but infection had not developed in any preceding case. It may be added it has not occurred in any succeeding case, and there was no more reason for fearing it in this than in the first operation.

This case epitomises our objections to the use of a nail or bone peg. As soon as the first screw entered the deep fragment, it tended to push it away from the other. But in the second operation a larger screw had the same effect until after its expanded head encountered the resistance of the external surface of the trochanter, after which the continued forcing inward of the screw pulled the deep fragment toward the outer one. The deeper the screw was driven, the more firmly the fragments were pressed together, a very important factor in finally assuring bony union. A nail would be more likely to separate the fragments and less likely to compress the fragment surfaces together. Nor can we agree with those who rely on screw or nail fixation without additional fixation from a plaster cast or traction. The poor blood supply to the small head fragment, coming only through the ligamentum teres with faulty or no fragment immobilization, undoubtedly accounts for the so-called partial or total necrosis found in heads removed from old ununited fractures of the femoral neck. It has not developed in any of our cases. A nail or even a screw would tend to become loose if nothing is done to prevent movement of the hip joint; and if the screw or nail became loose, union of the fragments could hardly be expected. Firm bony union resulted in all of our cases with screws except in the refracture without screws, in this fracture with screws following the first operation, and in the next case referred to and shown in Figure 3, Part 5.

Nonunion Two Years after Screw Fixation. From a severe fall a strong middle-aged woman sustained an intracapsular fracture of the femoral neck with the most severe typical displacement of the fragments that I have seen. (Fig. 3, Part 1.) It is my first screw fixation of these fractures in which union failed completely. An insurance company consulted a bone surgeon who advised an extensive operation. Because it was my first failure and because in my first four screw fixations the accident had occurred from four weeks to four months before operation, I advised a second trial of screw fixation, which I did about two years after the accident. The result is shown best in Figure 3, Part 5. The roentgenologist says there is still no union with which opinion I agree.

I shall attempt an explanation of the nonunion, which is not easily accomplished. These intracapsular fractures are trans-



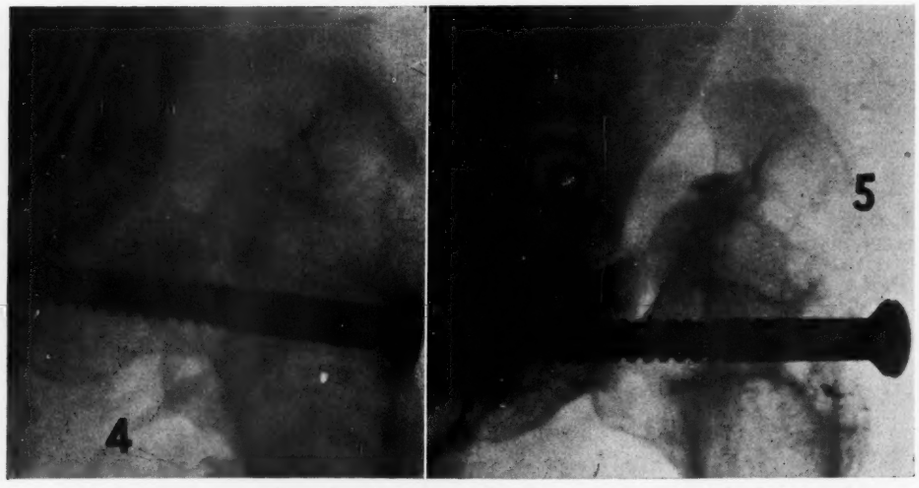


FIG. 3. Permanent nonunion after two screw fixations. 1, severe original deformity; 2, after reduction and first screw fixation; 3, before second screw fixation two years after first; 4, after second screw fixation; 5, permanent nonunion.

verse fractures of the neck, the angle of which with the shaft makes the fracture line almost correspond with the line of weight-bearing. The degree of displacement usually varies from a mild upward one of the lower fragment on the upper or head fragment, as in most cases, to an almost complete absence of end-on approximation, as in this case. This displacement is probably responsible for the failure of close approximation by the Whitman abduction cast, seen in Figure 3, Part 2, after operation, and Part 3 taken about two years after the operation. The case as shown in this figure and the preceding case with refracture and broken screws are the only ones showing so poor an approximation. It is my present opinion that this was the cause of the trouble in both, and that the refracture patient had walked on an ununited fracture until the refracture occurred so many months after the operation. This assumes that he walked and worked on the fragments supported by the screws until the refracture, which nonunion we have suspected for a long time but have been unwilling to assert until this case seemed to support the suggestion. However, there may have been some union.

The woman has used crutches since her cast was removed about three months after the operation, suggesting that union had never developed, a failure which did not occur in any other cases. Permission to begin weight-bearing was long delayed after the second screw introduction and the increase in weight-bearing was very slow. Figure 3, Parts 4 and 5 show the successive *x*-rays taken since. The most interesting development was that notwithstanding the *x*-ray evidence of nonunion, the weight-bearing ability increased. The patient walks about the home without crutches and with only a cane goes out on the street. It is difficult to decide what course to pursue. We know that a distinct weight-bearing ability can be present in the absence of bone union. We have no knowledge that any of the extensive operations done in these late stages produce better results. If pain becomes more troublesome, I would be inclined to advise removal of the screw and permit the trochanter fragment to develop support from the condensation of the surrounding connective tissue and the untorn joint ligaments. It has done this very successfully in many of these ununited fractures. It is in condition to do this successfully in this case after three years of nonunion in a very favorable position. The patient up to the present time is very well satisfied with her condition.

CHEMOTHERAPY IN OSTEOMYELITIS

ABRAHAM O. WILENSKY, M.D.
NEW YORK, NEW YORK

THE cumulative experience discussed in this communication is based upon that recorded previously in the literature, upon experiences related to me by other surgeons and pediatricians and lastly upon my own personal experiences. The material is composed of the ordinary run of cases of acute inflammation of the bones of bacterial origin (acute osteomyelitis); and no case of tuberculous or luetic infection is included. Chronic osteomyelitis is included only when recrudescences or exacerbations of infection bring it within the classification of an "acute" case.

The ordinary acute hematogenous cases are commonly due to infection by the Staphylococcus aureus. Extension cases of the skull following nasal accessory sinus infection are more commonly due to streptococci of the hemolytic and nonhemolytic groups. Extension cases following otological infection are due to streptococci and pneumococci most commonly. Primary cases of osteomyelitis, wherever they occur, are due to a variety of organisms depending upon environmental and causal conditions; commonly they belong to the colon groups; and in military wounds they form the commonest cause as a fecal infection due to the unnatural conditions of army life in the field. In considering the effects of chemotherapy with the new drugs of the sulfanilamide group, the bacteriology should be kept in mind as the various drugs exhibit different potencies with the various classes of bacteria.

The drugs of the sulfanomide group: sulfanilamide, sulfapyridine, sulfathiazole, sodium sulfapyridine, etc., can be administered by mouth, by hypodermic injection and by continuous subcutaneous and intravenous infusion. They can also be instilled locally into a wound, dissolved in plasma and reinjected into the circulation, and injected into the subdural cerebrospinal space by lumbar puncture. They can be combined with other drugs as arsphenamine or heparin, with antibacterial gas sera, with radiation therapy and with blood transfusions. Each of the drugs seems to have a special affinity for a different group or strain of bacteria. The drugs are rapidly absorbed and quickly excreted so that the dosage must be fairly large and frequently administered. They do not interfere with certain physiological functions such as blood groupings, with normal antibacterial activities and with bacteriophage action. When carefully administered and checked by repeated laboratory examinations the drugs are safe to administer and gastrointestinal and/or hematological complications can be entirely avoided or markedly ameliorated.

There is no absolute agreement as to which of the drugs is best except that sulfapyridine seems to work best with pneumococcic infections. At the present writing sulfathiazole seems to be in greatest favor for staphylococcic infections. My own experience is that all things considered, sulfanilamide works best in the general run of surgical infections, and in the latter type of case, none of the others has seemed superior. Apparently it is the custom to change from one to the other drug if no satisfactory results are quickly obtained; but in two severe cases of my own in which this method was tried, no perceptible difference was noted. Some of the observers put greater reliance on sulfathiazole. Sulfomethylthiazole shows too many toxic manifestations; but in a personal case in which this was tried after the others, no superior effect was noted. Azisulfamide is advised by Horan and French[7] when maximal concentration is desired in minimal time. Sodium sulfapyridine is advised

by the intravenous route for a similar reason, but in one personal case in which this was employed no effect was noted.

The drugs of the sulfanilamide group act in the animal body very much like they do in the test tube. For the necessary effect an intimate contact is necessary between the bacteria and the drug and this takes place either exclusively or to the maximum effect in the circulating body fluids—the blood, the lymph and fluids contained in or circulating in various hollow spaces (i.e., peritoneum, pleura, meninges, etc.). The effect is a bacteriostatic one and bacterial activity and growth are only inhibited. Destruction of the bacteria is facilitated and occurs during this dormant state by the natural antibacterial agencies in the body and the latter are more efficient after bacteriostasis is accomplished and while bacteriostasis is present. Therefore, drugs must be administered for a sufficient length of time and in sufficient concentration to enable them to work adequately; otherwise bacterial activity is not inhibited, the bacteria are not destroyed and the pathological condition increases. For this reason, recurrences occur frequently in clinical practice.

There is no complete agreement as to the best method of administration of these drugs. The main index of the sufficiency of the chemotherapeutic agent is the concentration in the blood; and, in order to make certain of this, blood determinations are necessary. Since the therapeutic aim is to attain a concentration in the blood of 10 to 15 mg. per 100 cc. as rapidly as possible, all available routes of administration should be attempted, by mouth, by hypodermoclysis and by the intravenous and intramuscular routes. Intrathecal administration is superfluous because it was noted by Marshall[11] that the concentration in the cerebrospinal fluid is close to the concentration in the blood. Not all patients of the same weight respond similarly to identical dosage, and one should, therefore, vary the dosage with different patients according to the concentration attained in the blood. Infants will tolerate the drug well, the dose being from one-third to one-half of the adult dose, while children require from one-half to three-fourths of the adult dose.

CLINICAL EXPERIENCE

In Acute Primary Osteomyelitis. The prophylactic use of the drugs of the sulfanamide group seem especially indicated in all civil accidental and operative bone wounds and in all bone wounds suffered in war in which infection might be expected to take root and flourish. This should not relieve one of the responsibility of employing all of the usual and well tried procedures (i.e., cleansing, débridement, etc., in all traumatic wounds (civil and military) and aseptic technic in all operative wounds) to which we have become inured by many years of successful usage. In spite of the fact that previously these measures have attained a high percentage of success, the helpful action of these drugs should be added in all suitable cases.

The latest preparations are in powder form and the powder may be insufflated directly into the wounds. In the general run of wounds sulfanilamide powder has served me excellently and I shall continue to use it prophylactically. Recently, sulfaguanidine has been proposed in cases in which the intestinal canal has been opened: the drug is not easily or readily absorbed but, nevertheless, exerts a continuous inhibitory effect upon the organisms inhabiting the intestinal tract with which it is placed in intimate contact. For the latter reason it is also recommended that the drug be given by mouth. In military wounds (battle wounds, bombing raid wounds, etc.), of the pelvis or lumbar spine in which the bowel is also opened, sulfaguanidine might be advantageously used as indicated.

In Acute Hematogenous Osteomyelitis with Especial Reference to the Long Bones. In order to understand the availability for and the therapeutic effectiveness of chemotherapy in acute osteomyelitis of the hematogenous variety, one should remember that the latter consists pathologically

and clinically of two distinct phases: (1) the initial phase of the general infection (i.e., with bacteriemia), and (2) the phase of development and progression of the local bone lesion.

(*a*) *Effect of Chemotherapy during the Stage of General Infection* (*Bacteriemia*). The available information corroborates the experimental work and makes clear that chemotherapy is therapeutically most active only during the phase of bacteriemia, when intimate contact can be established between the drug and the bacteria in the circulating blood; and that the effectiveness of action is directly proportional to the capabilities for and the thoroughness with which this intimacy can be accomplished.

When the proper member of the sulfanamide group is employed, and a sufficient concentration of the drug is established in the circulating blood for a sufficiently long time, the cumulative experience indicates that the general infection (i.e., bacteriemia) can, in the majority of the cases be eliminated fairly promptly. When this effect is obtained, that part of the clinical picture, which is caused by the presence of living bacteria in the blood stream (i.e., chills, at least part of the fever, toxicity, etc.), is either materially lessened or entirely eliminated in direct proportion to the effectiveness of the bacteriostatic action produced by the drug. In effect, this leads to an amelioration of the general clinical symptomatology; but this should not delude the clinician into believing that an equal effect is necessarily being produced in any existing local bone lesion *pari passu* with the general improvement.

Chemotherapy is not always capable of controlling the bacteriemia because the rate of production and discharge of the bacteria into the general blood stream is sometimes larger than their chemical inhibition and later destruction. This is not always due to the failure to produce the proper concentration of the drug in the blood stream; but, at the present writing, it seems most probable that it is due to the failure to make use of the drug sufficiently early. Widespread distribution of metastatic lesions in the visceral organs, musculature, etc., as well as in the skeletal system, may have preceded the exhibition of the chemotherapy and determine the persistence of any bacteriemia and the subsequent final fatal result.

(*b*) *Effect of Chemotherapy on the Local Bone Lesion.* Should a beneficent therapeutic effect on the general infection result from the chemotherapy, one is then left with one or more local bone foci. The local focus is a consequence of a local thrombo-embolus, the main characteristic of which is an exclusion of the sequestrated portion of the bone from the general circulation. Any bacteria present at these foci are locked away within the interior of the embolic area. Any intimacy of contact between the drug and bacteria is usually impossible because of the plugging effect of the thrombo-embolus. Theoretically, under such conditions, chemotherapy should yield no, or minimal beneficient therapeutic effects. Furthermore, bacteria could continue to grow within the thrombophlebitic area and could bring about various local complications, i.e., an infection in a joint. Then, too, if part of such an infected clot should break off or become dislodged to travel to and become blocked in a distant part of the body, metastatic lesions could occur and develop in spite of the saturation of the body with the chemotherapeutic drug.

Cumulative experience, including my own, indicates the entire agreement of clinicians with these theoretical considerations. In actual practice, chemotherapy is a failure as far as the local lesion is concerned for the above reasons and, above all, because the progression of the local bone focus is due to physical causes, i.e., the deprivation of a sequestrated area of its normal blood supply. While the general toxic symptoms may show a variable degree of amelioration, as indicated previously, the temperature may, nevertheless, continue as a reflection of local inflammatory conditions and activity and not

because of any general infection (bacteriemia). The local lesion usually proceeds to further development (necrosis and sequestration) and even to the production of its usual complications (e.g., an adjoining joint infection—brain abscess or meningitis from a cranial osteomyelitis—sinus thrombosis from a mastoid) which can lead to a fatal issue.

If the growth of any bacteria, excluded at first from contact with the general circulation because of its position in the thrombophlebitic area, should later succeed in forming contact with freely circulating blood, such an active thrombophlebitic process may continue the general infection (positive blood culture) by continuing to shed bacteria into the general peripheral circulation. In actual practice chemotherapy has no sterilizing effect under such conditions and, in order to sterilize the blood, it is necessary to eliminate by excision the offending segment of blood vessel which contains the infected thrombus.

There is almost laboratory proof of this statement in the clinical history of the following case:

> In a boy of twelve an acute hematogenous osteomyelitis of the tibia of severe grade developed; and, although the general signs of intoxication were ameliorated by sulfathiazole, a positive blood culture persisted equal to ten to fifteen colonies of bacteria to the cc. of blood cultivated. Then a thrombophlebitis of the associated saphenous vein was recognized; and, when the latter vein was excised, the blood became sterile and the boy made a complete recovery.

Sometimes excision of the active thrombophlebitic lesion is not possible because of its inaccessibility as in the anatomically related veins of the spine, the pelvis or the base of the skull. And the situations of deeply placed thrombophlebitic veins in the interior of the long bones, or in the extreme depths of their covering musculature are not always discoverable. Under such handicaps, chemotherapy has been mostly a failure clinically, even though an unprecedented brilliant unexplainable cure results rarely.

(*c*) *Effect in Chronic Osteomyelitis.* Chronic osteomyelitis is a continuation of the local lesion phase of acute osteomyelitis, usually of the hematogenous variety. Similar therapeutic results occur in any long standing ("chronic") case, during any period in which any recrudescence and exacerbation of infection, either locally, or generally, is accompanied by a demonstrable bacteriemia.

Anything which has been previously said regarding the treatment of the local bone focus in the acute stage applies with equal force in the long drawn out chronic stage. In making any deductions regarding the effects of chemotherapy in the chronic stage, one must make allowances for those disabling mechanical conditions, i.e., foreign bodies, sequestra, which prevent closure of the bone wound and its sinuses.

If the local focus harbors an open wound, some therapeutic effect of chemotherapy might be obtained by the local application of the drug in the wound. This, however, would be a purely surface phenomenon and would not influence the progression of the deep pathological condition.

In Extension Osteomyelitis. Extension osteomyelitis is most commonly found in the skull and is intimately bound up with nasal accessory sinusitis and with otogenous infections. All of the discussions must necessarily take into account the prophylactic effect of chemotherapy in these preceding infections: the effect in the treatment of the osteomyelitis itself; prophylactically in the prevention of the intracranial complications which so frequently occur; and therapeutically in the treatment of the latter.

In Extension Osteomyelitis of the Skull Following Accessory Nasal Sinus Disease. In the early stages of infection and in mild cases strictly limited in scope to the nasal accessory sinuses, chemotherapy seems to be unnecessary inasmuch as most of these cases undergo spontaneous resolution and cure. In the cases of severe infection of the

nasal accessory sinuses with high fever, chemotherapy seems to act favorably in bringing down the fever (Kramer;[8] Kulkin[9]); but Kramer[8] remarks that "the discomfort associated with the administration" of the drug "outweighs in most cases the benefits attained by the reduction in the temperature." In this regard it seems true that the indiscriminate use of the drugs of the sulfanamide group should be deprecated and certainly its use by the general public without adequate medical supervision should be restricted.

There is no prophylactic effect as far as the occurrence of any complicating osteomyelitis, and in any event the course of the infection should be carefully watched and controlled, because of the tendency of the drug to mask the spread of the disease into the cranial bones.

During the early stages of the development of any osteomyelitis of the cranial bones, chemotherapy seems to have a somewhat favorable effect upon the general clinical manifestations of fever, etc., even while the bone lesion is advancing. Otherwise, the following varied experience is available: the effectiveness of chemotherapy was doubtful because it was necessary immediately to combine with it surgical methods (Furstenberg);[5] at the University of Illinois the experience was frankly disappointing (Fabricant);[4] at the Mayo Clinic chemotherapy was "quite effective in the early stages of the disease" (i.e., osteomyelitis) but of little or no value once sequestration has taken place (Adson);[1] chemotherapy was fruitless in the treatment of an established osteomyelitis (Kramer);[8] chemotherapy was dangerous because of an undue reliance which might be put on the drug to the exclusion of the necessary surgery (Mosher);[13] and that in all cases the administration of these drugs has tended to obscure the further development of the clinical and pathological picture and the development of dangerous complications. My own experience parallels this in everyway; chemotherapy has not prevented the occurrence of osteomyelitis of the cranial bones; chemotherapy tended to mask the development and spread of the infection into the cranial bones; once established it has had no effect upon the osteomyelitis and surgical eradication of the disease was necessary.

The only contrary belief is that of Champ Lyons,[10] of the Massachusetts General Hospital, who reports good results from the use of chemotherapy in cranial osteomyelitis.

In Extension Osteomyelitis of the Skull Following Middle Ear and Mastoid Infection. Osteomyelitis of the mastoid, the petrous, and the squamous portions of the temporal bone occurs as a spread by contiguity from an infection of the lining membrane of the middle ear and associated cells of the mastoid.

Pediatricians report favorable prophylactic results from the use of chemotherapy in early cases of otitis media; but, in these early cases, favorable results are quite common without the use of chemotherapy. And great caution and careful observation are necessary in these early cases for fear of the drug masking the developing clinical picture and the spread of the infection into the bone.

Bowers'[2] results would indicate that when the drug is given early before bone softening has occurred, operation is decreased by half. Late treatment doubled the operative indication as compared with those treated early and adequately. In the experience of Horan and French[7] the incidence of mastoiditis was only 3.4 per cent, compared with 22.7 per cent before the introduction of sulfanilamide therapy. The experience is further corroborated by Hebble.[6]

The clinical experience with sulfanilamide at the Massachusetts Eye and Ear Infirmary has led Converse[3] to the belief that chemotherapy should not be routinely used as an adjunct to the usual measures for the treatment of infections of minor severity because: (1) Premature initiation of the drug therapy has made complete clinical evaluation of the patient difficult,

and progress of the infection to a complicating endophlebitis has been obscured during treatment, (2) There has been recurrence and further spread of the infection after omission of sulfanilamide in patients who had clinically appeared to be healed. (3) The danger of toxic manifestations necessitates the hospitalization of all patients receiving the drug.

Chemotherapy in the Intracranial Complications of Osteomyelitis of the Skull. According to Kramer[8] in rhinological cases, "the complications due to lymphatic and vascular involvement, with and without meningitis, have responded amazingly to the sulfanomid group. For the first time in rhinology recoveries have been obtained in patients with these complications." It has been "found . . . absolutely necessary, however, to attack surgically the source of the infection in order to obtain a permanent cure." At the Mayo Clinic, Adson[1] has also found it "of value in controlling and curing a number of patients with meningitis. It is of questionable value once a brain abscess has developed, but judging from their experience . . . it is quite effective if given in the early stages of acute encephalitis."

Maybaum[12] and his associates only use chemotherapy (sulfanilamide) in otitic complications—meningitis, sinus thrombosis and abscess of the brain. Removal of a bone focus or other localized pathological condition (extradural abscess) is imperative, but in the presence of extreme bacterial meningitis, intensive chemotherapy is advised for twenty-four to thirty-six hours prior to operation. In petrositis the drug is dangerous during the period of observation because of the tendency to mask the clinical picture, but once the diagnosis is made chemotherapy should be added to any operative manipulation. The drug is especially useful in continued otitic sepsis after a thorough surgical eradication of any localized foci has been done.

Chemotherapy has introduced a peculiar antagonistic effect. On the one hand chemotherapy may so mask the symptoms that an apparently symptomless meningitis may develop; on the other hand, chemotherapy is establishing a dominating place for itself in the successful treatment of meningitis. In the twenty-five years prior to 1936, only seventy-six recoveries from streptococcic meningitis were reported in the literature; since 1936 over 200 recoveries have been reported. Mortality has dropped from 97 to 35 per cent. Success in treating intracranial complications, according to Maybaum[12] and his associates, only follows when the original focus has been thoroughly eradicated, because while sulfanilamide is effective in clearing body fluids of bacteria, it is not effective when the latter are locked up in osseous tissue.

In the only personal experience I have had with intracranial spread of the infection chemotherapy seemed to have no effect. Sulfanilamide, neoprontosil, sulfathiazole, and sodium sulfapyridine were used, by mouth, hypodermically, by continuous subcutaneous infusion and by the intravenous route.

Latency of symptoms is further corroborated and commented upon by all observers (Converse,[3] Bowers,[2] Maybaum,[12] et al., Smith and Coon,[14] Hebble,[6] etc.). The apparently too early interruption of chemotherapy has been followed by unheralded intracranial complications after a period in which there was apparent more or less complete cessation of symptoms. An obligation is therefore created to continue sulfanilamide therapy, if once begun, until there is bacteriologic as well as clinical evidence of complete subsidence of the infection. Premature cessation of chemotherapy on clinical evidence alone permits exacerbations and recrudescences of infection in patients with ill prepared defensive mechanism.

Chemotherapy in Dento-alveolar Infections. Only a few oral surgeons and dentists are ready to make definite statements regarding the use of chemotherapy in dento-alveolar infections and their complications. The consensus of opinion seems to be that chemotherapy does not prevent the spread of infection from a purely dental

lesion into the substance of the jaw bone, nor the further progression of any resulting osteomyelitis or of its complications.

COMMENT

In actual practice, in the treatment of osteomyelitis, chemotherapy with the drugs of the sulfanamide group has not produced the consistently startling results which it has had in some medical conditions, notably the pneumonias. The observed results have varied all the way from the absolutely negative to occasional very satisfactory effects; they have been relatively good in the phase of general infection (bacteriemia), and relatively without effect and sometimes dangerous as far as the local bone focus of osteomyelitis was concerned.

The results of chemotherapy are not always predictable owing to the various obstacles, enumerated in this communication, to the efficient exercise of the bacteriostatic power of the drug, to the occasional difficulty of maintaining the proper concentration of the drug, to the necessity of matching the proper drug to the provocative organism, to the occurrence of certain toxic effects of the drugs themselves, and to the difficulty inherent in removing inaccessible foci of infection by surgical means. Chemotherapy has not prevented the spread of pathological conditions or the occurrence of complications, and in general surgical practice and especially in osteomyelitis have not been as satisfactory as one would wish. Sometimes the proper interpretation of good results is difficult owing to the possibility that such beneficent results have occurred spontaneously as they have done many times in the past before this form of chemotherapy was available.

Beneficent retrogressive changes are commonly seen and are common clinical knowledge in the clinical histories of many cases of acute osteomyelitis which in past years and before the advent of the new chemotherapeutic drugs have come under the care of all surgeons. Sometimes the beneficent improvements in the various aspects of the clinical, anatomical and pathological pictures attained remarkable extents and were most gratifyingly surprising when just the opposite outcome seemed imminent. Such unaided spontaneous outcomes undoubtedly are occurring today and will continue to happen.

In the new experience with chemotherapy such results also appear and it remains to be seen in the accumulated experience whether the actual and percentage relationships will be different or approximately the same. In any event in making any conclusions as regards the action of any of the new chemotherapeutic drugs in osteomyelitis the possibilities for spontaneous, unaided recovery should be remembered.

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TREATMENT OF LYMPHOGRANULOMATOUS STRICTURES OF THE RECTUM WITH SHORT WAVE DIATHERMY*

RICHARD T. SHACKELFORD, M.D. AND J. ARTHUR WEINBERG, M.D.
Assistant Visiting Surgeon, Johns Hopkins Hospital Assistant Visiting Surgeon, Johns Hopkins Hospital
BALTIMORE, MARYLAND

FOR many years patients with stricture of the rectum due to lymphogranuloma venereum have been returning to the rectal dispensary at the Johns Hopkins Hospital for whatever treatment was then in vogue. In 1940, Martz and Foote reported three men and two women with this disease whom they had treated with diathermy combined with Frei antigen inoculations. They obtained apparent cure in all five of these cases. Such an encouraging report led us to attempt our own evaluation of the method.

Lymphogranuloma venereum is a specific disease produced by a filtrable virus which is usually transmitted by sexual intercourse. The initial lesion is a small painless herpetiform or papular nodule which usually lasts only a few days and is unnoticed or disregarded by the patient. The secondary manifestations vary with the sex of the individual and the site of the primary inoculation. In the male the primary lesion usually occurs on the external genitalia and drains by way of the lymphatics to the inguinal glands resulting in the formation of buboes. In the female the site of inoculation is usually the cervix or the posterior vaginal wall and drains to the rectal and perirectal lymphatics causing a proctitis and perirectal fibrosis. The proctitis progresses, ulcerates and is usually associated with a profuse bloody purulent discharge. Elephantiasis vulva, anal condylomas, and perirectal abscesses and fistulas also occur as secondary manifestations. Occasionally, rectal lesions develop in the male as a result of direct implantation in the rectal mucosa by pederasty, by spreading up the rectal mucosa from a primary lesion at the anal margin or as an extension from a lesion on the urethral meatus to the posterior urethra which drains to the rectal and perirectal lymphatics. The tissue changes are those of a nonspecific granuloma. The diagnosis is made by the Frei test which is an allergic reaction to the intracutaneous inoculation of the sterilized extract from the exudate of a known lesion.

Almost every form of chemical, biological, radiological, electrical, surgical and physical treatment has been used without very promising results after the secondary manifestations have developed. Recent reports have offered attractive results with the use of the sulfonamides but our experiences with these have not been good when used late in the disease. We decided to treat some of our rectal strictures with diathermy alone. A short wave machine was used. A metal plate connected to one pole of the machine was applied to the lower abdomen and the other pole was connected to a Hegar dilator which was inserted into the strictured area. The largest dilator that could be inserted without causing the patient too much discomfort was used. Treatments were given from two to six times per week for a period of twenty minutes each, as much current being used as the patient could tolerate. Five patients were treated in the above manner and two patients were used as controls. In the controls similar Hegar dilators were inserted in a similar manner for periods of twenty minutes each but no diathermy was used. The following case reports show our results:

CASE REPORTS

CASE 1. L. B. (J. H. H., No. 104032), a female, forty years of age was first seen in the

* From the Departments of Surgery and Physiotherapy of the Johns Hopkins Hospital, Baltimore, Maryland.

gynecology dispensary on March 30, 1937, at which time she complained of pain on urination, dyspareunia and passage of fecal material through the vagina of two years' duration. She had been married fourteen years but had never been pregnant. Examination at that time showed elephantiasis of the right labia, condylomas acuminata about the rectum, a urethral caruncle and a fistula extending into the right buttock. A rectovaginal fistula and a dense stricture of the rectum were also present. The Frei and D'Melcos tests were negative at that time. She was admitted to the hospital April 5, 1937. Her rectal stricture was forcibly dilated under anesthesia. Following discharge from the hospital she returned to the rectal dispensary for weekly dilatations for forty-four weeks. On June 6, 1938, sulfanilamide orally was begun in addition to the weekly dilatations. This was continued for forty-one weeks with great improvement in the amount of discharge but persistence of the stricture. On September 19, 1938, the Frei test was positive and the following week, which was during the course of sodium sulfanilate therapy and weekly dilatations, the rectovaginal fistula was noted to have healed. She had had a total of ninety-eight dilatations up to this date. On May 20, 1940, the sodium sulfanilate was stopped and the patient began a series of twenty minute diathermy treatments in the physiotherapy department, three days weekly, with a No. 18, the largest size dilator. Barium enema *x*-ray study at that time showed a marked deformity of the rectum. On November 21, 1941, after four months of such therapy, totalling forty-eight treatments, the method was stopped at which time the stricture was still palpable and that portion within reach widely patent, although the discharge had ceased. An *x*-ray at this time, however, showed no change in the deformity of the rectum when compared to that made just previous to the instigation of diathermic treatments. All therapy was then discontinued and on January 21, 1941, she returned for a check up at which time examination showed the stricture still to be present but patent; the rectovaginal fistula remained healed and the *x*-ray after a barium enema remained the same as on her previous examinations. On May 26, 1941, she again returned with no symptoms but her local condition unchanged.

Fig. 1. Case III. Before diathermy treatments.

Fig. 2. Case III. At the end of diathermy treatments.

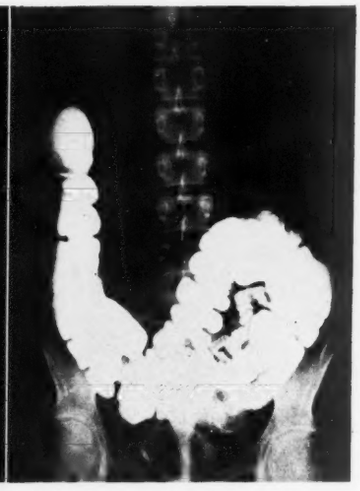

Fig. 3. Case III. Three months later.

Case II. C. M., (J. H. H. No. 177033). This twenty-eight-year old married, colored woman was first seen in the Johns Hopkins Hospital dispensary on September 22, 1939, at which time she was found to have a pharyngitis from which she rapidly recovered. On December 13, 1939, she returned to the gynecology dispensary with the complaints of tenesmus and bloody, watery stools of one year's duration. She also stated that the menstrual periods had been irregular for the past nine months and were associated with progressively increasing dysmenorrhea. Her immediate and most urgent complaint was the presence of a painful boil on her right thigh which had appeared one week previously. Examination on December 13, 1939, revealed an abscess on the right thigh, adjacent to the labia, bilateral inguinal adenitis, a purulent vaginal discharge and an irregular, nodular mass partially obstructing the rectum.

Her Wassermann test was negative. The urine contained pus and the blood showed a moderate leucocytosis. A diagnosis of lymphogranuloma venereum was made and she was started on sodium sulfanilate zii three times a day accompanied by weekly rectal dilatations. A barium enema on March 7, 1940, showed a constricted, deformed rectum with a dilated colon. On April 15, 1940, a rectovaginal fistula was found to have appeared. The sodium sulfanilate was stopped and the patient was started on physiotherapy treatments of twenty minutes each twice a week with a No. 10 dilator which was gradually increased until June 10, 1940, when a No. 18, the largest size could be inserted. This size was continued until cessation of treatment on July 19, 1940, after forty-three applications. On April 8, 1941, she was seen for a check up at which time the vesicovaginal fistula as well as the stricture were still present. An *x*-ray after a barium enema showed that the disease had progressed and the rectum was even more deformed than before treatment had been commenced.

Fig. 4. Case iv. Before diathermy treatments.

Fig. 5. Case iv. At the end of diathermy treatments.

Fig. 6. Case iv. Three months later.

Case iii. V. T. (J. H. H. No. 124871). In 1934, the patient had a full term, spontaneous delivery in this hospital and was found to have a positive Wassermann reaction. She was given antiluetic treatment during her pregnancy. Her history stated that three years previously at the time of her only other pregnancy she had been found to have syphilis and was treated for twelve months elsewhere, during which therapy she gave birth to a normal child. In 1935, she returned with an acute Bartholin's abscess which was incised and drained successfully. In January, 1936, she returned complaining of a rectal discharge of nine months' duration and was found to have elephantiasis of the labia, multiple fistulas-in-ano and rectal ulceration and stricture. She was admitted to the hospital on March 6, 1936, and the fistulas were excised. She was discharged from the hospital on March 12, 1936, and seen in the rectal dispensary on four subsequent occasions until April 8, 1936, when she disappeared. On February 26, 1940, she returned to the rectal dispensary because of marked constipation and discharge from the rectum. Examination then showed a tight, dense rectal stricture with almost complete obstruction, multiple fistulas-in-ano with abscess formation, condylomas lata and a rectovaginal fistula. The stricture was dilated with a Kelly clamp and she was started on sodium sulfanilate zii three times a day. She returned for dilatations twice a week and on March 15, 1940, *x*-ray after a barium enema showed a marked deformity of the rectum with nearly complete occlusion. On April 3, 1940, she was started on diathermy treatments five days a week beginning with a filiform dilator. The size of this was progressively increased until at the time of cessation of the therapy on October 25, 1940, after a total of eighty-four treatments a No. 17 could be inserted. An *x*-ray at this date showed the rectal lumen to be more patent but the deformity otherwise appeared the same. All therapy was then stopped and on February 21, 1941, she returned for a check up. At this time she had gained five pounds in weight, had few symptoms and though the stricture felt softer it was narrower than on her

previous visit. A barium enema showed both the deformity and the stricture to be more marked.

Fig. 7. Case VI. Before diathermy treatments.

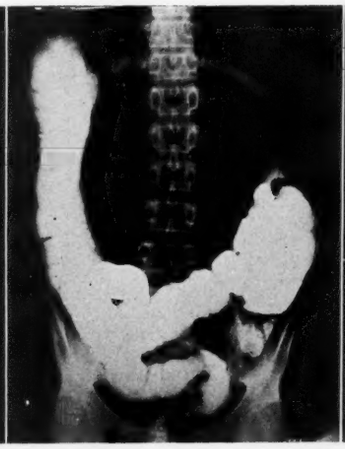

Fig. 8. Case VI. At the end of diathermy treatments.

Fig. 9. Case VI. Three months later.

Case IV. M. S., (J. H. H. No. 163822), a colored woman, was first seen in the out-patient department of the Johns Hopkins Hospital in June, 1933, at the age of thirty-eight for difficulty in defecation. Examination showed a dense stricture of the rectum which was gradually dilated to admit a No. 8 Wales bougie and she was discharged in March, 1934. She returned to the clinic in February, 1939, complaining of rectal bleeding and constipation. Examination then showed a dense stricture beginning two and a half inches above the anal margin which admitted a Kelly clamp with difficulty. The Frei test was positive. The stricture was dilated but the patient did not return to the clinic until April 18, 1940, when her symptoms had returned. At that time the stricture admitted a No. 10 Hegar dilator. *X*-rays showed a deformity and stricture of the rectum extending to the rectosigmoid junction. She was given bi-weekly diathermy treatments until October 25, 1940, receiving a total of fifty-six treatments. The stricture then admitted a No. 18 Hegar dilator with ease and she was symptom free. *X*-rays showed some dilatation of the distal portion of the stricture but the extent of the lesion had not changed. She returned to the clinic on February 12, 1941, for a check up examination. In the interim her bowels had moved daily and she had had no bleeding. The stricture had contracted slightly and admitted a No. 16 Hegar dilator. The surface was smooth and there were no signs of ulceration. *X*-rays showed the condition unchanged from the previous examination.

Case V. C. C., (J. H. H. No. 195513), a colored girl was first seen in the out-patient department of the Johns Hopkins Hospital in 1930 at the age of fifteen, complaining of a tender, swollen mass in the right groin. She denied the presence of any genital lesion and gave no history of a vaginal discharge. The mass was incised and drained and healed within three weeks. Several months later she began to have difficulty in defecation and noticed that her feces were occasionally streaked with blood, mucus and pus. She was seen in the rectal clinic and examination revealed a stricture of the rectum but she did not return for further treatment. She next came to the clinic in 1935 when she complained of abdominal pain and a profuse bloody diarrhea. She was admitted to St. Joseph's Hospital where a rectal stricture was dilated under an anesthetic and she was given intravenous tartar emetic. Her condition improved and she was discharged five months later. In March, 1940, she returned complaining of bloody diarrhea, fever, chills, nausea and vomiting. She was admitted to the Johns Hopkins Hospital on March 13, 1940. At that time rectal examination showed a dense stricture two inches above the anal margin, which admitted a Kelly clamp. Her hemoglobin was 42 per cent and the Frei test was positive. She was given two blood transfusions and her stricture was dilated. Her bowel movements decreased in number, her general condition improved and on March 27, 1940, she was started on rectal diathermy treatments. At that

time the stricture admitted a No. 8 Hegar dilator. She was discharged from the hospital on April 14, 1940, and her treatment was continued in the out-patient department. She received eighty-five treatments up to August 5, 1940, when her stricture admitted a No. 17 Hegar dilator and she was symptom free. Recent attempts to have her return for a check up examination have been unsuccessful and we know nothing about her condition since that date.

Case vi. P. S., (J. H. H. No. 13538—Control), was first seen in the gynecology dispensary in 1909 at which time her age was given as twenty-one. She then complained of a sudden onset of chills, fever and pains in her right hypochondrium. A diagnosis of acute pelvic inflammatory disease was made and she was given hot douches of pulvis menthol compound after which she recovered satisfactorily. Her only child was then six months old. In September, 1916, she returned with an abscess of her left vulva which was incised and drained, also followed by recovery. In January, 1918, she returned with a stricture of her rectum which was dense enough to require admission to the hospital for forcible dilatation under anesthesia. After two days of hospitalization and one visit to the dispensary she did not return for further treatment. In June, 1920, she returned to the laryngological clinic complaining of a sore throat. Her Wassermann test was negative. There were no rectal complaints and there is no note as to its condition at that time. In June, 1927, she returned to the gynecology dispensary with a marked rectal stricture and hemorrhoids and was admitted to the hospital for dilatation of the stricture under anesthesia. She remained from August 4 to August 10, 1927. In March, 1929, she returned to the rectal dispensary with a rectal stricture which was dilated at varying intervals over a period of five months with a No. 6 to a No. 8 Wales bougie, a total number of six dilatations. In October, 1931, she again returned with a dense stricture, a rectovaginal fistula and arthritis. She was given a course of tartar emetic with weekly dilatations for the next three years, receiving a total of sixty-six dilatations and injections. In January, 1935, her Frei test was reported positive and she continued dilatations at intervals as the stricture continued to recur. In March, 1936, *x*-ray with a barium enema showed an irregular, fusiform deformity of the rectum without occlusion.

In July, 1939, she returned nearly obstructed by her stricture and weekly dilatations were again carried out. In August, 1939, the *x*-ray was similar to that in 1936. On June 24, 1940, she was started on five daily dilatations per week in the physiotherapy department, having the dilator in place for twenty minutes and no diathermy being used. By this means, she was increased from a No. 12 to a No. 18 Hegar dilator, the largest size. A total of eighty dilatations were used. The treatment was discontinued until October 21, 1940, at which time a barium enema showed that the stricture was dilated in its distal portion which could be reached by the dilator, but the upper portion remained the same as before. All treatment was then stopped for three months. On December 2, 1940, it was noted that the palpable part of the stricture was again becoming narrowed and on February 3, 1941, another barium enema showed that the entire stricture had resumed the same amount of constriction as before the beginning of physiotherapy. She is now returning once weekly for dilatations with a No. 6 Wales bougie.

Case vii. M. N., (J. H. H. No. 203719—Control), a colored woman, aged thirty-five, came to the out-patient department of the Johns Hopkins Hospital on June 24, 1940. She was complaining of difficulty in defecation and a rectal discharge of three years' duration. In 1939, she had had a dilation of the rectal stricture at a hospital in Beckley, West Virginia. Following the dilation she had relief for several months and then her condition became gradually worse. When seen in our rectal clinic the lumen of the rectum was practically obliterated by a dense stricture beginning one and a half inches above the anal margin. There was a small dimple in the center which barely admitted the tip of a Kelly clamp. The surface was rough but not ulcerated. The Frei test was strongly positive. The stricture was gradually dilated and by July 1940, admitted a No. 14 Hegar dilator. From that date on she was used as a control and a Hegar dilator was inserted daily for a period of twenty minutes but no diathermy was used. She was given sixty-five treatments and left the clinic on October 11, 1940. At that time the stricture admitted a No. 18 dilator with ease and she was having no discharge. She returned to the clinic on May 5, 1941, seven months later. She had had no rectal discharge in the interim and had gained twenty pounds in weight.

Her bowels were moving daily and she had had no bleeding. The stricture had contracted slightly and admitted a No. 16 Hegar dilator with ease. The surface was smooth and there were no signs of ulceration.

It can be seen that all five of the patients treated showed local and symptomatic improvement at the conclusion of the course of diathermic dilatations. In one a rectovaginal fistula healed and has not recurred, in another, however, a rectovaginal fistula persisted unchanged.

Three to six months after treatment ceased the strictures had recontracted to some extent in all five of the patients treated. *X*-rays at this time showed little change from the original ones obtained before the instigation of treatment.

Two patients were used as controls and one of these (Case VII) showed the most marked improvement of any, and demonstrated little evidence of recontraction of her stricture. The other control showed temporary improvement at the end of her treatment but within three and one-half months the stricture had recurred to the same caliber as before therapy was begun.

CONCLUSIONS

From these facts we conclude that diathermy treatment *per se* to rectal strictures of lymphogranulomatous etiology, in our experience, offers very little if any curative effects. We believe that what benefits did result are primarily the effect of more frequent and prolonged dilatations that we had used in the past.

URINARY CALCULI AND RECUMBENCY*

ROBERT LICH, JR., M.D.
Chief of Genitourinary Surgery,
U. S. Marine Hospital

AND

ROBERT MANSFIELD, M.D.
Chief of Surgical Staff,
U. S. Marine Hospital

LOUISVILLE, KENTUCKY

THE close relationship between urinary calculi and recumbency is generally not adequately appreciated. Orthopedic surgeons often witness calculus in patients confined to bed for long periods. Medical men, too, find such cases now and again but are not generally cognizant of their frequency nor the methods of prevention. Hence, recumbency and calculi of the urinary tract are not commonly associated in the mind of the attending physician.

In a review of the various standard systems of medicine, surgery and pediatrics no mention of prophylactic care in reference to urinary stones was found in the sections on treatment of the different chronic disorders. However, the urological and surgical literature, both of this country and abroad, contains a number of articles on recumbency associated with urinary lithiasis. Wesson, in 1931, reported a series of cases in which twenty-three out of 150 men suffering with fracture of the femur developed renal calculi. Wallenstein reported a case of bilateral renal calculi five weeks after immobilization for a fracture of the spine. Mawson frequently found the condition in orthopedic patients eighteen months to fourteen years of age who were being treated for such disorders as tuberculosis of the spine and hip, slipped epiphysis, septic arthritis of the hip and knee, acute myelitis, spina bifida and celiac disease. Keyes, in 1936, found a 15 per cent incidence of urinary stones in 200 children examined in an orthopedic hospital. Goldstein and Abeshouse reviewed the literature and added fourteen additional cases. McCague made the observation in his series of ten cases that the average period in bed was five months, but that the diagnosis of stone was not made until twenty months following the injury. To this list of contributors may be added the names of Crowell, de Faria, Pulvertaft, Armstrong, Webster, Wood, and Carlson and Ockerblad. From this brief review of the literature it is obvious that this condition, though not common, is far from being a medical curiosity.

In this paper four cases are recorded: First, a case of anterior poliomyelitis with several calculi in the renal pelvis which developed within three months while the patient was confined in a respirator; second, a patient developing a stone in a lower renal calyx that was diagnosed ten months following his injury, compound fracture of the tibia and fibula. Following a five-week convalescent period the patient complained of back pain intermittently but refused a urologic work-up until he was stricken with an acute stone colic. A third patient developed a silent hematuria following a fracture of both bones of the leg. Intravenous pyelography definitely established the diagnosis of multiple renal calculi. The fourth case was that of a chronically ill patient who developed a ureteral calculus after four years of interrupted invalidism. Previous pyelographic studies demonstrated conclusively that this stone developed during the patient's long illness.

PATHOGENESIS

The etiology of renal calculi is a complex and controversial subject; however, in this particular phase of the subject there are observations which will aid us in our appreciation of the cause of renal calculi occurring in the bedfast patient. As is well known, when any bone in the body is not

* From the Departments of Surgery and Urology, U. S. Marine Hospital, Louisville, Kentucky.

used, it undergoes a loss of some of its calcium salts, and when the muscular system is put at rest there occurs muscular atrophy with a concomitant reduction in the blood supply. Therefore, the reduced muscular blood supply creates a relative hyperemia of the bone, which in turn promotes rarefaction. Grieg has summarized this process as follows: "Maintain the circulation within certain limits and bone remains unchanged; produce a definite hyperaemia and bone undergoes rarefaction, decalcification, osteoporosis; restrict the blood supply and bone undergoes consolidation, increased density, osteosclerosis; cut off the blood supply and the bone undergoes necrosis."

Injury and infection produce local skeletal decalcification. Imperfectly mobilized fractures with constant trauma induced to the bone ends result in eventual rarefaction. Infection destroys bone as is seen, for instance, in finger felon or osteomyelitis.

Although calcium is not excreted primarily through the kidney, the urinary calcium is markedly increased during a period of bone decalcification. In the event that the urine becomes highly concentrated, the calcium salt may reach a point of supersaturation and initiate a precipitate of inorganic calcium. A so-called "mudstone" is thus formed in the renal pelvis, ureter or bladder. If conditions are favorable, additional calcium is precipitated and the calculus grows until the entire renal pelvis may be filled, finally impairing kidney function.

This mechanism of salt precipitation from a saturated solution is effective in the production of calculi during recumbency, since most of these stones are composed of calcium phosphate. The carbonates, urates, and occasionally, oxalates, play a minor part in the composition of these calculi. When the calculus is complicated by infection a triple phosphate (ammonium magnesium phosphate) stone mixed with fibrin and other organic constituents occurs.

The rôle of infection in the precipitation of urinary salts is not a factor in this particular circumstance, since a large proportion of renal stones accompanying recumbency are found in sterile urine. When urinary infection is present it is usually introduced in one of four ways: (1) Urethral instrumentation; (2) ascending urinary infection due to uncleanliness, especially in the female; (3) infection of bone or other foci, delivered to the kidney via the blood or lymph; and (4) through constipation due to atonia of the abdominal musculature accompanying the inactivity of recumbency.

The exact rôle of vitamins in the etiology of calculi is a matter of conjecture. The fact that such authors as Osborne, Mendel, and Ferry, Grossman, Higgins, Livermore, Bliss, and Prather have reported that experimental animals develop renal calculi on vitamin A free diets is certainly no indication that vitamin A is essential in the prevention of urinary calculi. This latter point is particularly emphasized by Clausen, who suggests that the answer lies in a closer scrutiny of clinical records rather than animal experimentation.

The advocates of vitamin A deficiency believe that stones are formed in one of two ways: (1) the deficiency causes a metaplastic keratinization and desquamation of the urinary tract epithelium, thus supplying a nidus for crystalloid deposition (McCarrison; Higgins; Hryntshak; Steiner, Zuger, and Kramer); (2) the calculi form because dietary deficiency causes an alkaline urine with the resulting precipitation of salts (Higgins; Osborne, Mendel, and Ferry; Ravich).

Higgins has reported that in the Cleveland Clinic 68 to 74 per cent of the cases of renal lithiasis gave photometric evidence of vitamin A deficiency. Also, Ezickson and Feldman, in 1937, found that twenty-four out of their twenty-five cases of urinary lithiasis showed vitamin A deficiency. These results are interesting and suggest a possible association, but they do not constitute unquestionable proof. In fact, the work of Youmans, Jeans, and Zentmire shows that vitamin A deficiency goes hand-in-hand with an inadequate diet rather

than with any definite tendency to stone formation. In short, the problem of lithiasis and vitamin A deficiency is still unsolved.

SYMPTOMATOLOGY

Hematuria is the foremost symptom (macroscopic or microscopic finding) in urinary calculi associated with recumbency. Hematuria is usually first manifest when the patient's position is radically changed, that is, when the patient, after being bedfast for several weeks, is changed from the dorsum to the ventrum, or when he is allowed out of bed. Renal colic, another manifestation of urinary stone, is usually accompanied by a microscopic hematuria. However, in renal stone associated with enforced recumbency, kidney colic is far less common than is hematuria.

In some few cases renal calculi manifest their presence by the sudden appearance of chills and fever of unknown origin. This, of course, is indicative of an associated infection and a microscopic examination of urine will make the diagnosis. It must be remembered, however, that a true pyonephrosis may be present in conjunction with renal stones and the urine will give no hint of renal infection.

SIGNS

The renal calculus without infection does not afford diagnosis by any physical diagnostic signs. However, when obstruction occurs the usual sign of renal pelvic distention is present—tenderness to deep pressure at the costovertebral angle of the affected side.

The abdomen, even during acute attacks of renal colic, may or may not reveal evidence of muscle spasticity, though the patient often complains of a generalized abdominal tenderness to deep palpation.

DIAGNOSIS

The roentgen ray affords the only means of positive diagnosis. When the stone is suspected, and the usual flat plate of the abdomen reveals a suspicious shadow in the path of the urinary tract, the diagnosis can usually be established by intravenous pyelography. Cystoscopy is contraindicated in the uninfected case because of the danger of introducing infection. For this reason, cystoscopy for diagnosis of renal stone formed during recumbency is definitely undesirable until the patient has been given ample opportunity to combat the condition by medical treatment in the form of urinary acidification for calculus dissolution.

TREATMENT

Prophylaxis. The prevention of renal stones is, of course, the prime consideration. In the recumbent patient it has been demonstrated repeatedly that uninfected renal calculi can be dissolved by urinary acidity (Pyrah and Fowweather). Hence it follows that, in the absence of infection, stones can be prevented. However, the factors of stone formation must be considered carefully in any form of therapy directed toward calculus prevention.

Decalcification of bone must be kept at a minimum. Decalcification can be best reduced by active movement of the parts of the body not involved by the primary disease process, and massage of the affected parts affords protection from local bone hyperemia and its consequent decalcification (Pyrah and Fowweather).

The fluid balance of the individual must be carefully controlled so that urinary salt precipitation is prevented. The patient must take at least 2,500 cc. of liquid daily, and more if the fluid loss is great due to such factors as fever, diarrhea, or vomiting. Heliotherapy must be controlled in order to avoid an excessive fluid loss. Boyd emphasizes particularly this factor of physiologic renal lavage.

The dietary regimen must be carefully planned through the entire course of the recumbent period. Since the diet must produce an acid ash, proteins are of very definite importance. Meats, fish and cereals should be included in the diet daily and vegetables and fruits should be intelli-

gently employed since they produce an alkaline urine.

The fluid administered must yield an acid ash, for it would be sheer folly to advise an acid ash diet and permit alkaline ash fluids to be taken freely. Fruit juices yield an alkaline ash, whereas barley water produces an acid ash. Fluids, then, such as barley water and those of neutral reaction such as water are to be preferred for the maintenance of urinary acidity. Urinary acidity is qualitatively, not quantitatively, important in calculus prophylaxis.

Repeated urinalyses are an essential part of the medical regimen. At weekly intervals urinary hydrogen ion content should be determined and certainly at intervals no longer than a month microscopic examinations of the urine should be done so that a stone will be discovered long before its subjective manifestations.

The value of vitamin A therapy in urinary calculi is still a moot question. However, since it seems that patients with stones often exhibit a vitamin A deficiency it may be advisable to estimate their vitamin saturation. To date there is no accurate method for estimating the amount of vitamin A, but the biophotometer serves to give at least a relative index (Cantarow). Normally at least 3,000 International Units of vitamin A should be ingested daily by adults and at least twice that quantity by children. If this cannot be accomplished by the diet, vitamin A may be given as capsules of carotene in oil (Higgins). The intake of the other vitamins should be adequate in any satisfactory diet. Vitamin D should be administered as cod liver oil, since hypervitaminosis may play a rôle in calculus production (Putscher, Thatcher).

At not longer than forty-eight to seventy-two-hour intervals the patient must be made to change position completely. This constitutes moving the patient from the dorsum to the ventrum; the half way mark affords little, if any, benefit. Armstrong reports that in the two and a half years since he has made a practice of moving his patients at regular intervals, no urinary tract complications have arisen. Furthermore, Pulvertaft claims that 27 per cent of urinary stones formed during recumbency disappear spontaneously if renal drainage is aided through the frequent change in position of the patient.

The unintelligent use of the urethral catheter is positively contraindicated in patients whose long recumbency is anticipated. Every means to initiate spontaneous urination in the individual who experiences acute urinary retention must be employed before resorting to catheterization with its almost certain aftermath of urinary infection. Methods employed to stimulate spontaneous urination are hot compresses to the suprapubic region, immersing the hand in warm water, letting the patient hear the flow of water, etc. If these methods should prove fruitless, one of the cholinergic drugs such as mecholyl, or even the more powerful doryl, may be employed. A fair trial of these methods should precede urethral catheterization. However, if the use of the catheter is imperative, it is important to give the patient immediately and for the following few days some suitable urinary antiseptic. Intravenous uritone is useful in the event of nausea or vomiting. The acid urinary antiseptics (methenamine with ammonium chloride or mandelic acid) are more desirable since urinary acidity should be maintained.

A properly selected diet will automatically produce an acid urine of sufficient intensity to keep urinary salts well in solution, but the unco-operative patient needs supplementary acid medication. Ammonium chloride, if tolerated, is a very effective urinary acidifier. In the event ammonium chloride is not well tolerated, acid ammonium phosphate or acid sodium phosphate may be prescribed in similar doses (Mitchel). Boyd, on the other hand, warns against the use of this drug because of its ability to create a phosphaturia.

Patients who require long periods of bed rest need careful supervision of the intestinal tract. Atony of the abdominal musculature favors constipation, which, in turn, is

often the forerunner of an Escherichia coli urinary tract infection. Also, such compounds as sodium bicarbonate and magnesium oxide must be judiciously prescribed, and this is true of saline cathartics containing phosphates and sodium bicarbonate (Boyd).

Calculus prophylaxis during enforced recumbency may be summarized as involving essentially three considerations: (1) adequate renal drainage and lavage; (2) the production of a urinary hydrogen ion content conducive to crystalline solvency, and (3) the prevention or early eradication of urinary tract infection.

Stones in an Uninfected Urine. The various factors discussed under prophylaxis should be carefully considered and followed in attempting to dissolve calculi in uninfected urine. The point of prime importance is the production and maintenance of a highly acid urine. A large fluid intake is essential and must be maintained even if parenteral fluids must be administered, the attempt being to dissolve the calculi by acidification and physiologic renal lavage. That this is possible has been demonstrated by Pyrah and Fowweather, Wesson, Pulvertaft, and by one of the authors (R. L.).

Stones in Infected Urine. Regardless of the amount of infection, this condition resolves itself eventually into a surgical problem. The fibrin and other organic material deposited in the stone matrix produce a body insoluble to any marked degree in any of the present day medications.

SUMMARY

1. There is a definite relationship between recumbency and urinary stones.

2. Factors for the prevention of renal calculi during recumbency are urinary acidity, urinary dilution, prevention of urinary stasis, and prevention of bone decalcification.

3. Aseptic urinary stones can be dissolved by urinary acidity and the maintenance of a sufficient urinary flow.

4. Renal stones in the presence of infection constitute a surgical problem.

5. Four cases of urinary calculi following recumbency, seen by the authors, are briefly mentioned.

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PRIMARY MALIGNANT TUMORS OF THE TESTICLE*

PHILIP ROSENBLATT, M.D.,
Resident in Pathology, Jewish Hospital of Brooklyn

DAVID M. GRAYZEL, M.D.
Associate Director of Laboratories, Jewish Hospital of Brooklyn

AND

MAX LEDERER, M.D.
Director of Laboratories, Jewish Hospital of Brooklyn

BROOKLYN, NEW YORK

WITHIN recent years the subject of intrinsic testicular neoplasms has attracted the renewed attention of investigators. Attempts at clarifying the confusion in classification have generally succeeded only in adding new terms to an already overburdened terminology.

The first description of a testicular tumor was that of St. Donat,[1] in 1696, who reported an obvious teratoma. No real progress was made until 1845 when Sir Astley Cooper[2] distinguished cystic from solid neoplasms and assigned the former a somewhat more favorable prognosis. Johnson,[3] in 1856, recognized the tridermal nature of some testicular tumors, but it remained for Langhans,[4] in 1887, to classify the tumors, with the aid of histological sections, according to their structure. He suspected that a large proportion of all testicular tumors were teratomatous, a view which Wilms[5] consolidated in 1896. Wilms further suggested that the homogeneous neoplasms represented an overgrowth of one germ layer which destroyed and obscured the remains of the other germ layers. This view was generally accepted until 1906 when Chevassu[6] sharply dissented. He divided testicular neoplasms into roughly equal halves, of which the one group comprised the teratomas. The second, consisting of homologous tumors, were considered to be anaplastic neoplasms originating in the germinal epithelium. This nonteratomatous group he called "seminomes" to describe their origin.

The dualistic concept of Chevassu remained unchallenged for only a short time. In 1911, Ewing[7] reviewed the subject and reverted to the unitarian concept of Wilms. He reaffirmed the teratomatous origin of practically all testicular tumors and stated that these tumors arose from misplaced primordial totipotent germ cells in the region of the rete testis. The seminoma of Chevassu he considered to be merely a one-sided overgrowth of a single germ layer and he termed it "embryonal cell carcinoma." Ewing described a case of embryonal carcinoma in which he found minute traces of cartilage which "would have been overgrown and eradicated by the rapidly advancing carcinoma."

Thalheimer and Geist,[8] and Eisendrath and Schultz,[9] however, continued to support Chevassu's dualistic concept and Bell[10] even described transition stages. Bell also added the term, spermatocytoma.

Robert Meyer[11] noticed the similarity of Chevassu's "seminoma" and Ewing's "embryonal carcinoma" to ovarian dysgerminoma. Meyer suggested the term "dysgerminoma of the testis" for this group since he believed that these tumors arose from undifferentiated germ cells that are found in the gonads before sex differentiation occurs. Thus he added another term to the already confusing terminology.

Many tumors of the testicle are associated with the presence of gonadotropic hormone in the urine. Biological assays were recommended by Ferguson,[12] in 1934, in order to clarify the study of testicular neoplasms. He states that the quantitative

* From the Department of Laboratories, The Jewish Hospital of Brooklyn, New York.

determination of prolan A is a definite indication of the structural type of the tumor and that the more embryonal its

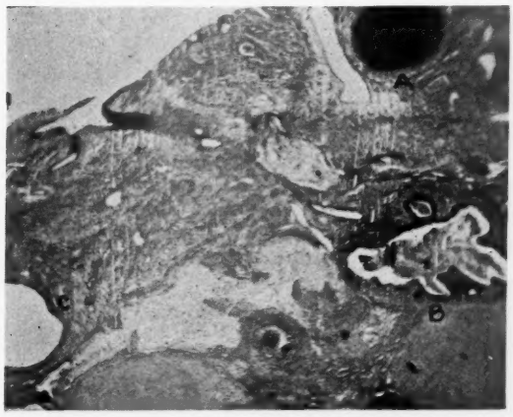

Fig. 1. Case XIII. Benign teratoma showing (A) cartilage, (B) structure resembling bronchiole, and (C) cysts lined with flat epithelium. × 48.

character, the greater the output of hormone, and that the excretion of prolan A is increased by the presence of metastases.

In 1940, Melicow[13] presented a classification of testicular tumors on the basis of pathological embryology. He recognized teratologous and nonteratologous groupings, placing in the former, Ewing's embryonal carcinoma. In the latter group, under the new heading "malignant seminocarcinoma," he designated as a homonym, Chevassu's "seminoma."

Christopoulos[14] devised a classification in which he recognized the anatomical similarity between "seminoma" (dysgerminoma) on the one hand and "embryonal carcinoma" on the other. He believes that the latter are a monodermal development arising from cells of the somatic blastomere which had become included in the mesenchymal core of the testis during segmentation of the fertilized ovum and involution of the somatic blastomere. Tumors of this origin, he states, usually have hormonic influences. On the other hand, the group of dysgerminomas he considers not to be teratomas in the pure sense, since, like Meyer, he believes that they arise from neutral cells which are formed in the otherwise normally differentiated mesenchyme of the testis. These tumors, arising from neutral cells, therefore, are without hormonic influence. Thus, Christopoulos also uses hormone assays

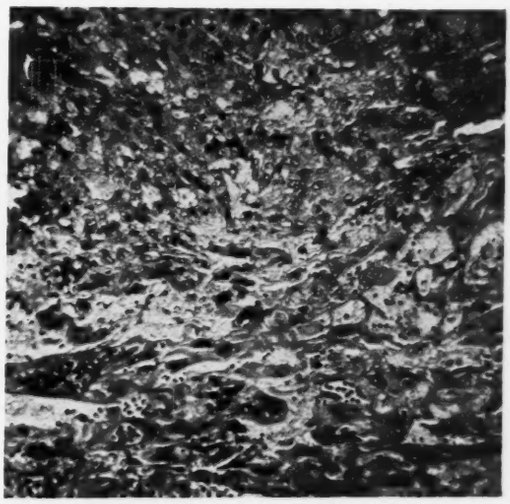

Fig. 2. Case XVII. Chorionepithelioma metastatic to lung. Note large sheets of decidua-like cells. × 300.

as one of the distinguishing criteria between Ewing's embryonal carcinoma and that anatomically similar group which is biologically inert and which he prefers to call dysgerminoma.

Gordon[15] recently reviewed a series of 142 cases and presented evidence favoring the teratomous origin of essentially all primary testicular neoplasms. He was unable to find any transitions between normal germinal epithelium and embryonal carcinoma (seminoma).

We were able to classify our twenty-nine cases as follows:

1. Heterologous tumors:
   - (a) Adult teratoma..... 1
   - (b) Teratoma with malignant changes..... 6
   - (c) Chorionepithelioma..... 2
2. Homologous tumors:
   - (a) Embryonal carcinoma..... 20

Little difficulty was encountered in classifying the heterologous tumors. In the homologous group, however, no differentiation could be recognized anatomically between the embryonal carcinoma of the testis (Ewing) and the dysgerminoma (seminoma) of the testis (Meyer). Furthermore, no correlation could be established

between the histological picture and the biological properties of the tumors in this series. Ferguson[12] stated that in "em-

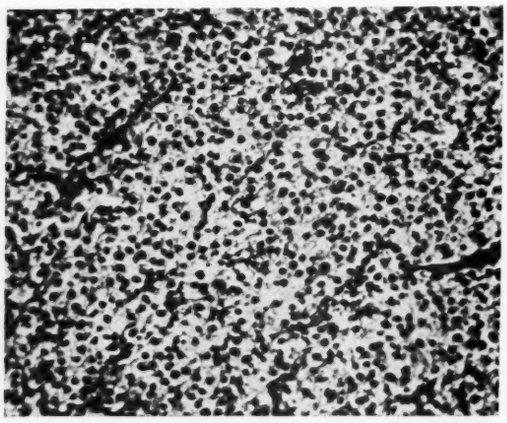

Fig. 3. Case xxix. Embryonal carcinoma without lymphoid stroma. × 300.

bryonal carcinomas with lymphoid stroma" the excretion of prolan A in the urine is greater than in seminoma. A similar observation was made independently by Stevens.[16]

Aschheim-Zondek tests were done in eight cases in this series of homologous tumors; two were reported as positive and one as doubtful. In both cases with positive reactions the stroma was scanty and contained only scattered lymphocytes, whereas in some of those reported negative the lymphoid tissue and stroma were abundant.

Because of the difficulty experienced in differentiation either anatomically or by their biological behavior, it was decided to group them, as suggested by Ewing, under the all inclusive term of embryonal carcinoma of the testis.

Pathology. Teratoma is a complex tumor composed of tissues and organs derived from the three germ layers. An adult teratoma is one in which the tissues are fully differentiated and arrange themselves in an orderly fashion. These are relatively benign neoplasms and, according to Higgins and Buchert,[17] they constitute only 5 to 10 per cent of all teratomas. In our series, we found one adult teratoma in a group of nine heterologus tumors, an incidence of 11 per cent.

The teratoma with malignant changes is analagous to Ewing's embryoid or teratoid tumors. This group of neoplasms is made

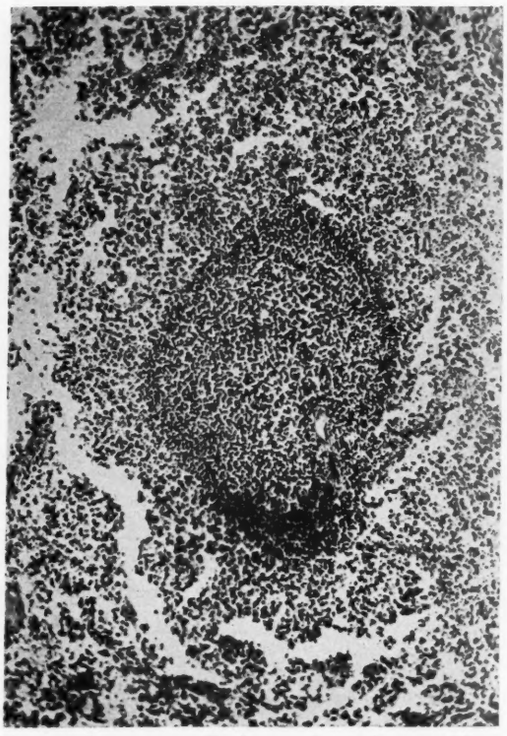

Fig. 4. Case xxvi. Embryonal carcinoma. Note accumulation of small round cells in follicle-like arrangement. × 300.

up of tissues derived from two or more germ layers in which one or more elements show definite malignant tendencies. We usually append the descriptive term, "carcinomatous" or "sarcomatous" change, as the case may be. However, we do not place too great stress upon this feature because, due to its heterologous potentialities, the primary tumor or its metastases may in different places show combined carcinomatous, adenocarcinomatous or sarcomatous features. For example, one of our cases may be briefly reviewed:

Case v. The patient was a twenty-seven year old married man, admitted September 11, 1938. He stated that in April, 1938, while pushing a hand truck, he felt a sharp pain in the right groin which extended to the testicle. One month later he noticed swelling of the right testis. During the four months prior to hospitalization, he had considerable pain in the

right groin and testis, and he noticed a variation in the amount of testicular swelling. On examination, an irregular tender mass was palpated in the region of the right epididymis. The testis was felt posterior and adherent to the mass.

The clinical impression was hematocele with tumor of the testicle to be excluded. Right orchidectomy was performed on September 12, and a hard nodular tumor mass was found extending into the testicle and involving almost the entire upper pole.

The testicle measured 7 by 4 by 3.5 cm. One area, 4 by 3 cm. was firm, and on section, pale grey in some places, dark brown and bright red in others. The remainder of the testicle was pink and soft. Here, the seminiferous tubules teased easily.

Microscopically, one portion showed tumor tissue and uninvolved portions of the testis. The former presented a variegated picture. In some areas there were nests of large polyhedral cells with abundant granular cytoplasm and large vesicular nuclei with one or more nucleoli. The cytoplasmic borders were distinct in some cells, indistinct in others. Mitotic figures were occasionally seen. In places, the cells were arranged in cords or nests, and even tended toward acinar formations. Tumor cells were seen within endothelial lined spaces. The stroma was broad and infiltrated with eosinophiles, small and large mononuclear cells, and some polymorphonuclear leukocytes. Other zones showed large spindle-shaped cells varying greatly in size and shape with large oval hyperchromatic nuclei lying in a loose, scant stroma densely infiltrated with cells as above. Still other zones showed both types of cells participating in the tumor formation. With the Van Gieson, Mallory's aniline blue, and Laidlow's connective tissue stains, the tumor tissue was seen to be made up of epithelial, connective tissue, and muscle cells. Diagnosis: Teratoma testis with carcinomatous and sarcomatous changes.

The Aschheim-Zondek test was repeated and was negative. The patient made an uneventful recovery and was discharged September 18. In May, 1939, he was again hospitalized because of pain in the right lumbar region of one week's duration. *X*-ray examination revealed right hydronephrosis. Right nephrectomy was performed. At this time it was noted that the middle third of the right ureter passed through retroperitoneal nodular tumor tissue. The patient recovered from the operative procedure and was discharged June 11, 1939. The Aschheim-Zondek test was again reported as being negative. In September, 1939, the patient died at home with extensive metastases. The entire duration of the disease was about one year.

The chorionepithelioma is a curious tumor which is similar to the like tumor in the female. It is composed of syncitial masses of chorionic epithelium and unquestionably is the most malignant tumor of the testis. The primary growth is often very small and clinically unrecognized. Widespread hematogenous metastases, especially to the lungs, occur early and sudden hemoptysis may be the presenting symptom. The extremely high titer of gonadotropic hormone in the urine of patients with chorionepithelioma is of great diagnostic and prognostic significance. Both patients died within seven months of the onset of symptoms despite vigorous therapy.

Ormond and Prince[18] state that in most series, heterologous and homologous tumors appear in almost equal numbers. In our series, however, only nine of twenty-nine neoplasms were heterologous, an incidence of 31 per cent.

In the homologous group of tumors we found no instances of pure sarcoma, such as have been described in the literature. We reviewed our old cases which were so diagnosed and were able to place them all into the group of embryonal carcinomas.

The homologous tumors are composed of large round to polygonal cells with scanty cytoplasm and poorly defined cell membranes. The nuclei are large, round to oval in shape, and vesicular in character. As a rule, the constituent cells are loosely arranged in irregular alveoli demarcated by a fibrillar stroma. Lymphocytic infiltration may be marked, but is often absent. Areas of hemorrhage and necrosis are common and occasional giant cells are seen.

In our series, the embryonal carcinoma comprised 69 per cent of the entire group.

Incidence. Malignant tumors of the testicle are rare. At the Henry Ford Hospital, Ormond and Prince[18] report that of 319,000 men, women and children treated since its founding in 1915 only twenty-one malignant testicular tumors were found. MacKenzie[19] reports twenty-seven cases in 307,174 admissions at the Royal Victoria Hospital. At the Jewish Hospital of Brooklyn, since 1915, we have found twenty-nine cases in 169,600 general hospital admissions excluding children, obstetrical cases and newborns.

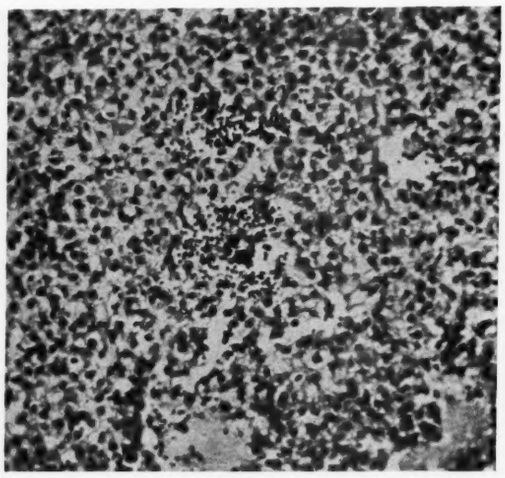

FIG. 5. Case I. Embryonal carcinoma with diffuse scatterings of small round cells. × 300.

Age. Malignant tumors of the testicle appear most frequently during the period of greatest sexual activity, that is between the ages of twenty and fifty years. In the series reported by Higgins and Buchert,[17] 87.5 per cent of the cases occurred in this age group. Dean[20] reported a series of 292 cases in which the patients varied in age between one year and seventy, the average being 33.5 years. Forty-three per cent of the patients were between twenty-five and thirty-five years of age at the time of the first symptoms while 80 per cent were less than forty. In our series, the youngest patient was fifteen while the oldest was seventy-two years of age. In the series reported by Gilbert and Moody,[21] the average age at the time of onset was thirty-one years, and 86 per cent occurred between the ages of twenty and fifty years. In our series, 86.2 per cent of our cases fell between the age limits of twenty and fifty years.

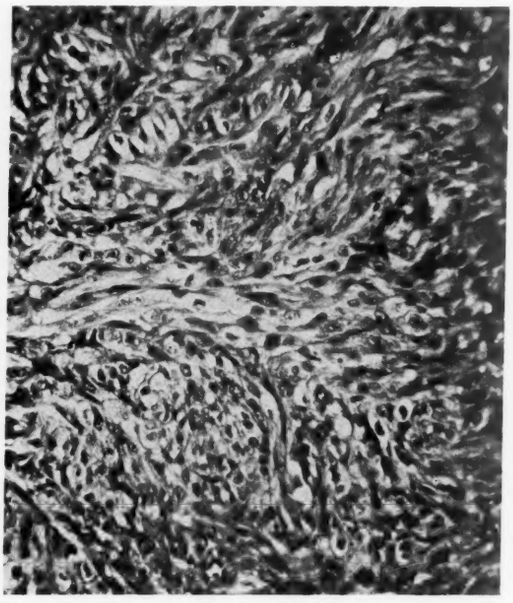

FIG. 6. Case V. Teratoma with sarcomatous change. × 300.

Simpson[22] reports the greatest incidence of teratoma between twenty and thirty years, while that of seminoma is between thirty and forty years. In our series, the average age incidence in the group of heterologous tumors was twenty-seven years, while that of the homologous neoplasms was 37.2 years. This would seem to indicate that the teratomas appear in an earlier age group than the embryonal carcinomas.

Side Involved. Reports in the literature vary as to the predominence of tumors in the right or left testicle, but all agree that bilateral involvement is rare. In Dean's[20] series, the right side was involved in 52.2 per cent of cases, the left in 47.6 per cent. He stated that the difference could be accounted for by the greater frequency of undescended testicle on that side. In the series of Gilbert and Moody, the right side was involved more frequently than the left. In addition, he reported two cases of bilateral growths. We found the right side involved sixteen times (55 per cent), the left thirteen times (45 per cent).

Trauma. The relation of trauma to tumor in the testis is also of great interest from a medicolegal point of view. Injury to the testicles is common and it is easy to attribute enlargement of the organ to a preceding trauma. Most authorities, however, seem to believe that physical insult to the testicle, while it may call attention to a growth hitherto unnoticed or excite more rapid growth in a small pre-existing tumor, can hardly arouse malignant degeneration in a previously normal organ.

The incidence of trauma in different series varies rather widely: Kirshbaum and Jacobs,[23] in thirty cases, report an incidence of 36.8 per cent; Higgins and Buchert[17] report 19.2 per cent; in Dean's[20] series of 124 cases the incidence of trauma was 11 per cent, while Rea[24] reviewing seventy-six cases, observed that 38 per cent of his patients had experienced definite trauma. In our series only three patients gave a history of previous injury to the testicle, an incidence of 10.3 per cent.

Duration of Symptoms. The testicle is a very prominent organ and it would commonly be supposed that recognition of disease would be early. Surprisingly enough, this is not the case and many patients procrastinate for an extremely long time before seeking medical advice. In most series, the average elapsed time between the onset of symptoms and medical consultation is one year to eighteen months. In our series, advice was sought from two weeks to fifteen years after the onset of symptoms, the average being 15.2 months.

Clinical History. It is said that there are no pathognomonic signs or symptoms of a malignant tumor of the testicle. The first symptom ordinarily noted is an increase in size of the testicle, this being painless and accompanied by a feeling of weight or fullness in the scrotum. In 92 per cent of the 124 cases reported by Dean,[25] in 83 per cent of the cases reported by Higgins and Buchert,[17] increase in size of the testicle was the first sign. In our series, fifteen patients (53.6 per cent) presented themselves because of painless enlargement of the testicle. In Tanner's[26] series, 52 per cent of the patients complained of pain, while twelve (41.4 per cent) of our patients suffered from this symptom.

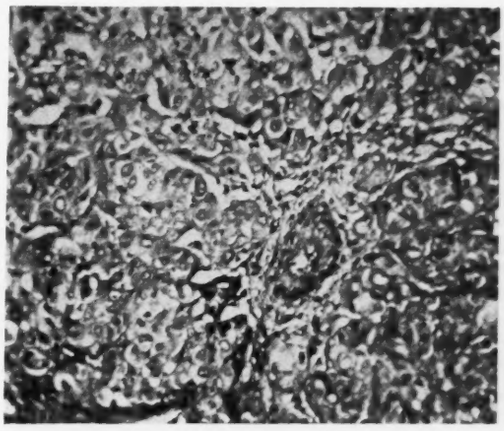

Fig. 7. Case v. Teratoma with carcinomatous change. × 300.

Constitutional symptoms such as weakness, pain in the back, anorexia and loss of weight are almost invariably manifestations of metastases. In Case iv the patient complained of back pain in addition to testicular symptoms. In this instance the patient died with widespread retroperitoneal metastases. Case vii initially complained of coughing up a large blood clot and *x*-ray examination revealed metastatic nodules in the lungs. Attention to the testicular neoplasm in Case xxiv was attracted by symptoms of prostatism. The testicle was found to contain a hard nodular mass and was removed in the course of the first-stage prostatectomy. The real nature of the testicular mass became apparent only after histological examination.

Follow-up of Cases. Higgins and Buchert[17] state that a review of the literature and of their own cases leads them to the conclusion that the end results of treatment in cases of malignant tumors of the testicle are quite discouraging. In the series of Gilbert and Moody,[21] only three of twenty-one patients were alive with an average survival period of thirty-one months. Ormond and Prince[18] found the prognosis best in those patients who had no visible

TABULATION OF DATA ON TWENTY-NINE CASES OF TESTICULAR NEOPLASM

Case No.	Age	Presenting Symptom	Duration	Side	Trauma	Aschheim-Zondek Test	Orchidectomy	*X*-ray Therapy (Preop. Postop.)	Metastases on Admission	Original Pathological Report	Final Pathological Report	Follow-up to July, 1941
I	33	Swelling of testis	3 mos.	L	No	Positive	Yes	Postoperative	No	Embryonal carcinoma	Embryonal carcinoma	Died in 2 years
II	36	Swelling of testis	1 yr.	R	No	Negative	Yes	None	No	Embryonal carcinoma	Embryonal carcinoma	Well 3 years
III	21	Swelling of testis	2 wks.	R	No	....	Yes	Postoperative	No	Teratoma with malignant changes	Teratoma with malignant changes	Died in 2 years
IV	49	Swelling of testis; pain; back pain	7 wks.	L	No	Negative	Yes	Postoperative	Yes	Embryonal carcinoma	Embryonal carcinoma	Died in 10 mos.
V	27	Swelling of testis; pain	5 mos.	R	No	Negative	Yes	None	No	Teratoma with malignant changes	Teratoma with malignant changes	Died in 18 mos.
VI	32	Swelling of testis; pain	1 mo.	L	Yes	Positive	Yes	Preoperative	No	Chorionepithelioma	Chorionepithelioma	Died in 8 mos.
VII	21	Hemoptysis; cramping abdominal pain; loss of weight	4 mos.	R	No	Positive	No	Yes	Yes	Chorionepithelioma	Chorionepithelioma	Died in 4 mos.
VIII	26	Swelling of testis; pain	9 mos.	R	No	Positive	Yes	Preoperative	No	Embryonal carcinoma	Embryonal carcinoma	Well 5 yrs.
IX	37	Swelling of testis	1 yr.	R	No	....	Yes	Postoperative	No	Embryonal carcinoma	Embryonal carcinoma	Died in 1 year
X	36	Swelling of testis	6 mos.	L	No	....	Yes	Postoperative	No	Embryonal carcinoma	Embryonal carcinoma	Well 6 years
XI	33	Swelling of testis; pain	8 mos.	L	Yes	....	Yes	....	No	Embryonal carcinoma	Embryonal carcinoma	Well 7 years
XII	34	Swelling of testis	6 mos.	R	No	Negative	Yes	....	No	Teratoma with malignant changes	Teratoma with malignant changes	Well 7 years
XIII	26	Swelling of testis; pain	5 mos.	L	No	....	Yes	No	No	Spermacytoma	Adult teratoma	Well 11 years
XIV	32	Swelling of testis; pain	4 mos.	L	No	....	Yes	Postoperative	Yes	Embryonal carcinoma	Embryonal carcinoma	?

TABULATION OF DATA ON TWENTY-NINE CASES OF TESTICULAR NEOPLASM—(*Continued*)

Case No.	Age	Presenting Symptom	Duration	Side	Trauma	Aschheim-Zondek Test	Orchidectomy	*X*-ray Therapy (Preop. Postop.)	Metastases on Admission	Original Pathological Report	Final Pathological Report	Follow-up to July, 1941
XV	35	Swelling of testis; pain	5 mos.	L	No	....	Yes	....	No	Teratoma with malignant changes	Teratoma with malignant changes	?
XVI	29	Swelling of testis; pain	15 yrs.	R	No	Negative	Yes	Preoperative	No	Embryonal carcinoma	Embryonal carcinoma	Died in 1½ years
XVII	29	Swelling of testis	3 yrs.	R	No	....	Yes	Postoperative	No	Embryonal carcinoma	Embryonal carcinoma	Died in 22 years
XVIII	43	Swelling of testis	3 yrs.	R	Yes	....	Yes	....	No	Embryonal carcinoma	Embryonal carcinoma	Well 3 years
XIX	21	Swelling of testis	3½ mos.	R	No	....	Yes	....	No	Teratoma with malignant changes	Teratoma with malignant changes	Died in 2 years
XX	26	Swelling of testis	6 mos.	R	No	....	Yes	Postoperative	No	Teratoma with malignant changes	Teratoma with malignant changes	Died in 3 years
XXI	36	Swelling of testis	2 mos.	R	No	....	Yes	Postoperative	Yes	Sarcoma	Embryonal carcinoma	Died in 3 years
XXII	22	Swelling of testis	4 mos.	L	No	....	Yes	....	No	Sarcoma	Embryonal carcinoma	?
XXIII	70	Swelling of testis; pain	11 wks.	L	No	....	Yes	....	Yes	Sarcoma	Embryonal carcinoma	?
XXIV	72	Dysuria; dribbling	3 yrs.	L	No	....	Yes	....	No	Embryonal carcinoma	Embryonal carcinoma	?
XXV	15	Swelling of testis; pain	5 wks.	L	Yes	....	Yes	Postoperative	No	Sarcoma	Embryonal carcinoma	Died in 4 mos.
XXVI	34	Swelling of testis	1½ mos.	R	No	Negative	Yes	Postoperative	No	Embryonal carcinoma	Embryonal carcinoma	Well 1 year
XXVII	27	Swelling of testis; pain	1 yr.	L	No	....	Yes	....	No	Sarcoma	Embryonal carcinoma	?
XXVIII	38	Swelling of testis	3 yrs.	R	No	Negative	Yes	Postoperative	No	Embryonal carcinoma	Embryonal carcinoma	Recent
XXIX	24	Swelling of testis	1½ mos.	R	No	Doubtful	Yes	Postoperative	No	Embryonal carcinoma	Embryonal carcinoma	Recent

metastases at the time of orchidectomy and who received radiation therapy postoperatively. Higgins and Buchert[17] also found a distinct margin in favor of those patients who received *x*-ray therapy plus orchidectomy.

Ferguson[12] cites Dean as reporting five-year cures in 29.2 per cent of a series of 154 patients treated with *x*-ray alone. Coley[27] reports favorable results by the combined use of orchidectomy and his streptococcus and bacillus prodigiosus toxin. Hinman[28] and Young[29] prefer the radical operation, despite its operative mortality rate of close to 5 per cent. In general, it can be stated that no matter what therapy is employed, the prognosis should be guarded.

In our own series, we were able to obtain follow-up data in twenty-three of twenty-nine cases. Of these thirteen patients died with a survival period ranging from four months to twenty-two years after the onset of the disease. Excluding the latter case, the average period of survival was seventeen months.

The case of the patient who survived twenty-two years is of such unusual interest that it is reported briefly below:

Case xvii. No. 156584. The patient was first admitted to the hospital on February 9, 1911, at the age of twenty-nine years, with a three-year history of painless enlargement of the right testicle. Simple orchidectomy was performed and a diagnosis of round-cell sarcoma was made on the pathological specimen (re-check showed this to be an embryonal carcinoma).

In November, 1922, eleven years following the procedure, he was admitted to another hospital because of pain in the right upper quadrant of the abdomen. A diagnosis of retroperitoneal sarcoma was made and he was given a course of deep *x*-ray treatments.

He was seen again at this hospital twice in 1923 and in 1924, at which times indefinite masses were palpable in the right lower abdominal quadrant and in the hypogastrium. These masses were not tender and immobile. The patient was given another course of *x*-ray therapy between his third and fourth hospitalizations.

The patient was admitted to this hospital for the last time January 20, 1933, with a four-weeks history of increasing dyspnea, dependent edema, swelling of the abdomen, hemoptysis and severe abdominal pain. He expired March 29, 1933, and an autopsy was obtained. The postmortem findings included malignant thromboses of the left renal and spermatic veins, mesenteric and portal veins, and metastatic embryonal carcinoma in the liver and in the peripancreatic lymph-nodes.

Obviously, this patient developed metastases eleven years following orchidectomy, which, however, were controlled by radiation therapy for another period of eleven years before he died of recurrences.

Of the thirteen patients who died, seven were in the group of homologous tumors, while six were heterologous. Of the ten patients who are alive at this time, two may be excluded because they are too recent to be significant. Amongst the remaining eight cases, six were homologous neoplasms, and two heterologous. One of these heterologous tumors was the instance of adult teratoma, and this patient is alive and well eleven years following orchidectomy.

In analyzing these figures, one is immediately impressed with the high mortality in the group of heterologous neoplasms. Despite vigorous postoperative *x*-ray therapy and the absence of metastases on admission, all died within three years of the onset of symptoms. The two patients with chorionepithelioma expired four months and eight months after the onset of the disease, respectively.

In the survival group of ten cases, two instances of embryonal carcinoma are excluded from analysis because of their recent vintage. Of the remaining eight cases, as noted above, two were in the heterologous group but only one showed malignant changes. This patient is alive and well seven years following orchidectomy, despite the fact that no radiation therapy was given. The average life span following orchidectomy in these eight instances is five and one-third years.

CONCLUSIONS

1. Testicular tumors occur most frequently between the ages of twenty and fifty years.

2. Heterologous tumors appear in an earlier age group than the homologous neoplasms.

3. Bilateral testicular neoplasms are rare. The right testicle is more frequently involved than the left.

4. In our series trauma was reported in 10.3 per cent of cases.

5. The average duration of symptoms in our series was 15.2 months before medical advice was sought.

6. There are no pathognomonic signs of testicular neoplasm, but painless enlargement is the most common presenting symptom.

7. The heterologous tumors offer a poorer prognosis than the homologous neoplasms.

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VITAMIN K AND ITS RÔLE IN BLOOD COAGULATION*

ARTHUR J. D'ALESSANDRO, M.D.
Assistant and Lecturer in Postgraduate Surgery, New York University Medical School
NEWARK, NEW JERSEY

THIS review will present our present concept of the mechanism of blood coagulation, a brief discussion of the factors involved in blood coagulation and a more detail discussion of the experimental and clinical uses of vitamin K.

MECHANISM OF NORMAL BLOOD COAGULATION

Plasma contains a substance, *prothrombin*, which is activated in the presence of *calcium* and a platelet or tissue factor, *thrombokinase*, to form an active coagulant, *thrombin*. Thrombin reacts with *fibrinogen* to form an insoluble split product *fibrin* in the network of which the formed elements and serum are enmeshed to form an elastic structure, the blood clot. This is the classical Wöhlisch theory, based on the elementary facts of coagulation first established by Schmidt in 1893, and extended by the work of Hammersten and others.

Out of the multiplicity of divergent views of blood coagulation, there are two well established fundamental facts: (1) The formation of thrombin from its precursors (prothrombin, calcium and thrombokinase), and (2) the conversion of fibrinogen to fibrin under the influence of thrombin.

The facts can be expressed in the form of equations:

$$\text{prothrombin} + \text{thromboplastin} + \text{calcium} = \text{thrombin}$$

$$\text{thrombin} + \text{fibrinogen} = \text{fibrin}$$

The relation of these reagents, calcium, thrombokinase, prothrombin, thrombin and fibrinogen along with other coagulants and anticoagulants to coagulation will be briefly summarized.

Calcium. A deficiency of calcium has not been found in hemorrhagic diseases. Even in the marked hypocalcemia of parathyroid insufficiency no alteration of the blood clotting can be demonstrated. Similarly, the high blood calcium in hyperparathyroidism does not bring about any appreciable change in the coagulation time. Calcium in its ionized state was previously considered indispensable as one of the precursors of thrombin but more recent investigations have shown it to act in the organically combined state. Quick has recently brought forth evidence indicating that the important calcium factor is intimately tied up with the prothrombin molecule.

Thrombokinase. Thrombokinase is one of the most widely distributed elements involved in blood clotting occurring plentifully in almost all tissues and being highly concentrated in brain, lung tissue and blood platelets. It is absent in the circulating blood except in abnormal conditions when it immediately activates prothrombin to thrombin. It is thought to be a protein phospholipoid compound. As its name implies, its action in activating prothrombin is supposedly of an enzymatic nature. Eagle believes that the rôle of platelets in initiating coagulation in shed blod has been exaggerated and that the thromboplastic factor of greatest importance is a dissolved plasma constituent. This theory is supported by the recent work of Lenngenhager in 1936 which indicates that platelet disintegration may be the result, rather than the cause of coagulation. He believes that the thromboplastic material primarily responsible for coagulation is present in the plasma as a dissolved material, which is activated by contact with a foreign surface to form the actual thrombokinase. In support of this theory is cited the fact that

*Read at the Surgical Seminar at New York University.

mammalian plasma carefully drawn and devoid of all cellular elements including platelets usually does clot. Patek and Stetson also found that normal cell-free plasma contains a factor associated with the globulin fraction. If this is added to hemophilic blood the blood is rendered normally coagulable. This factor may well be the thromboplastic substance of Lenngenhager and this factor is now suspected of being deficient in hemophiliacs rather than any increased platelet stability as previously supposed.

Prothrombin. Prothrombin has been one of the least understood reagents in the chemistry of blood coagulation. Recent developments following the discovery of vitamin K have thrown considerable light on this substance. It is now known that it is essentially a product of liver metabolism, although it may be obtained from bone marrow as well and its concentration in the blood is directly dependent upon the assimilation of vitamin K. As the precursor of thrombin a deficiency of prothrombin results in a diminished blood coagulation.

The plasma concentration of prothrombin is indirectly determined by various tests such as that of Quick or Warner, Brinkhous and Smith.

Thrombin. Although not a normal constituent of blood plasma, thrombin may be found in minute quantities through the interaction of its precursors (prothrombin and thromboplastin). On this basis Howell has postulated the presence of an anticoagulant normally in the blood. The latest evidence indicates that prothrombin and thrombin are both carbohydrate containing proteins.

Fibrinogen. Fibrinogen is one of the best understood elements in coagulation. It is a protein known to be formed in the liver and normally present in the blood plasma in concentrations of 0.3 to 0.7 per cent. Fibrinogen is normally present far in excess of the amount necessary for coagulation. Only a few isolated reports of cases have appeared in which fatal hemorrhage could be attributed to a lack of fibrinogen in the blood. Synthesis of fibrinogen is one of the last products of metabolism to be abandoned by a diseased liver. Bancroft and his co-workers noted that the fibrinogen concentration of human plasma is higher in infectious diseases and lower in profound liver disturbances. They believe that a fibrinogen concentration of over 0.8 per cent predisposes to phlebitis when associated with infection.

The exact mechanism of the thrombin-fibrinogen reaction has not yet been clarified. There is a growing belief in an enzyme action in transformation of prothrombin into thrombin in the presence of calcium as the first stage of blood coagulation; then thrombin in turn behaves as an enzyme in activating fibrinogen to fibrin. However, the recent work of Mertz, Seegers and Smith in demonstrating a linear relationship in the utilization of prothrombin and thrombokinase in the formation of thrombin casts some doubt on the enzymatic nature of this phase of coagulation.

Anticoagulant. One of the most complex problems in the mechanism of blood coagulation concerns the presence of a physiological anticoagulant. Many theories have postulated the presence of a physiological anticoagulant, which, until the discovery of heparin in 1916, defied all experimental verification.

Coagulant. In 1939, Seegers, Warner, Brinkhous and Smith obtained a remarkably effective solution of thrombin which is used as a hemostatic agent for the uncontrollable oozing which accompanies certain types of surgery, especially in patients with diminished blood coagulation. The solution, 1 cc. of a 1 per cent solution which will clot 1 cc. of blood in two seconds, is used as a spray on the operative field and is especially good in controlling bone bleeding and in cranial surgery. Bleeding from incised liver tissue was checked in five seconds or less. Clinical application of this agent is pending further investigation due to a difficulty in sterilizing the solution.

In concluding the discussion of the elements concerned in coagulation, until more

is known about the true nature of prothrombin and thrombin, our concepts of blood coagulation must remain in the realm of theory. Even theory has not as yet correlated all the experimentally confirmed facts.

HISTORY OF VITAMIN K

Hemorrhagic Disease of Chicks. In 1929, Henrik Dam, of Copenhagen, first reported a hemorrhagic disease in chicks reared on a fat-free diet. Similar observations were made by MacFarlane, Graham and Richardson in 1931 and Holst and Halbrook in 1933. The blood of these chicks, when allowed to stand overnight, failed to clot. A vitamin C deficiency was suspected though lemon juice was not curative.

In 1934, Dam and Schönheyder reported that ascorbic acid, cod liver oil and wheat germ oil failed to influence the hemorrhagic tendency, thus eliminating vitamins C, A, D and E as etiologic factors.

In 1935, Dam named the etiologic factor of this hemorrhagic disease, the "koagulation vitamin" or vitamin K.

Vitamin K and Prothrombin. Since the addition of normal plasma to blood of bleeding chicks restored the coagulation time to normal, the defective element must reside in blood plasma. Dam, Schönheyder and Tage-Hansen succeeded in demonstrating that the defective element was prothrombin. Similar reports were simultaneously and independently published by Almquist and Stokstad, and Quick in this country.

Prothrombin Tests. The association of vitamin K with prothrombin was readily followed by the development of more accurate tests for prothrombin than were possible by the old Howell method. Most noteworthy of these new tests was that published by Quick in 1935 and the dilution test of Warner, Brinkhous and Smith reported a short time later. Both tests utilize the addition of excess tissue factor to recalcified blood plasma. The prothrombin levels are reported in percentage deviation from the eighteen to twenty-two seconds required by normal plasma to coagulate. The bleeding tendency, however, may not become manifested until the prothrombin levels fall to below 30 or 20 per cent of normal.

Vitamin K and Bacteria. In 1936, Almquist and Stokstad of California and two years later Almquist, Pentler and Mecchi presented evidence that microorganisms are capable of synthesizing the vitamin in food, feces or in pure culture.

Jaundice and Prothrombin. Although Wedelius, in 1683, first reported a death from bleeding in a jaundiced patient, the cause of cholemic bleeding remained unknown until 1937 when Quick postulated that the coagulation defect was due to a prothrombin deficiency. Experimental investigations immediately confirmed this fact with the result that cholemic bleeding, heretofore responsible for an average of 15 per cent of all deaths on biliary tract surgery, is now a rarity.

Vitamin K and Bile Salts. Hawkins and Brinkhous observed in the course of their experiments upon dogs with biliary fistulas in 1935 and 1936 that the bleeding tendency in these dogs was associated with low plasma prothrombin, which could be restored to normal merely by returning bile to the intestinal tract. Meanwhile Greaves and Schmidt were conducting experiments indicating the necessity of bile for adequate absorption of fat-soluble vitamins A, D and E, and now vitamin K was added to this group. The action of bile salts is purely a physical one. Early in 1938 clinical evidence began to accumulate indicating that fat-soluble vitamin K was required by all species and was not limited to birds and that the presence of bile in the intestine was essential for its absorption.

By 1938, Brinkhous, Smith and Warner in Iowa, Dam and Glavind in Copenhagen, and Snell, Butt and Osterberg of the Mayo Clinic, all had succeeded in restoring the prothrombin levels in jaundiced patients and in correcting the bleeding tendency by the administration of bile salts and vitamin K.

Vitamin K and Liver. Smith, Warner and Brinkhous next reported on the harmful effect of chloroform poisoning of the liver on the plasma prothrombin, which was seen to fall to as low as 5 per cent of normal after ninety minutes of chloroform anesthesia in a dog. Under these circumstances the blood fibrinogen is not affected. Similar drastic drops in plasma prothrombin was shown to follow partial or total hepatectomy in dogs, indicating that an adequately functioning liver is essential for the utilization of vitamin K in the production of prothrombin. Autopsy findings of extensive liver damage, from one cause or another, in those patients who failed to respond to the usual vitamin K therapy further confirmed this association of liver and prothrombin production.

Vitamin K and Hemorrhagic Disease of the Newborn. Rodda, in 1920, called attention to the defective coagulation of blood in infants in the first few days of life, but no explanation was offered until 1937 when Brinkhous, Smith and Warner reported that the blood prothrombin level of infants is very low when compared with adult values, the average being about one-fourth the adult concentration. It has been shown that the infant blood prothrombin falls from the second to fourth or sixth day of life when it may again reach the birth level, but does not reach the adult level until about the end of the first year. This fall is even more pronounced in premature infants. It is a well known fact now that vitamin K is produced by bacterial action. Logically it follows that as soon as the baby ingests food or water, it infects its intestinal canal, which at birth is sterile. With the establishment of an intestinal flora the synthesis of vitamin K begins, thus producing a rise in prothrombin after the first week of life. This explanation might account for Javert's observation that hemorrhagic disease is twice as common in babies born in the New York Hospital, where feedings were prepared according to the most sanitary methods, as in babies born at home.

In 1939, Waddell, Guerry, Bray and Kelley reported on the administration of vitamin K concentrates to two infants with very low prothrombin levels and prolonged coagulation time with the dramatic and rapid restoration of normal values. More extensive clinical evidence promises a marked reduction in the incidence of hemorrhagic disease in the newborn, now estimated at one in every 200 births. Hellman and Shettles found that the low prothrombin levels usually prevailing in newborn infants could be elevated by administering the vitamin to mothers prior to delivery.

Synthesis of Vitamin K. The developments in vitamin K in the past year have been chiefly concerned with the isolation, purification and synthesis of this important new vitamin. For most of this work the world is indebted to Doisy, McKee and their co-workers. Thus in five years we have witnessed developments, the ultimate appreciation and implications of which will not be realized for some years to come.

CHEMISTRY

Natural Vitamin K. The original vitamin K concentrates were obtained from alfalfa by Dam and from putrefied fish meal by Almquist. In 1939, Doisy and his associates isolated two distinct substances from these sources; naming the one from alfalfa vitamin K_1, and that from fish meal, vitamin K_2, as both had the same biologic activity in different degree. The common denominator of both vitamins was a 1, 4-naphthoquinone.

Synthetic Vitamin K. In 1939, Almquist and Klose reported on the use of synthetic phthiocol which is water soluble and could be administered intravenously without the need of bile salts. The natural phthiocol is a normal metabolic product of the tubercle bacillus. Soon many more vitamin K-active naphthoquinone derivatives were reported, of which 2-methyl-1, 4-naphthoquinone is the most potent and the one most commonly used clinically today. This product is also water soluble and much more potent

than natural vitamin K or phthiocol. Synthetic vitamin K is the first example in the discovery of vitamins in which the synthetic substance is of greater biologic activity than the pure natural vitamin. (Fig. 1.)

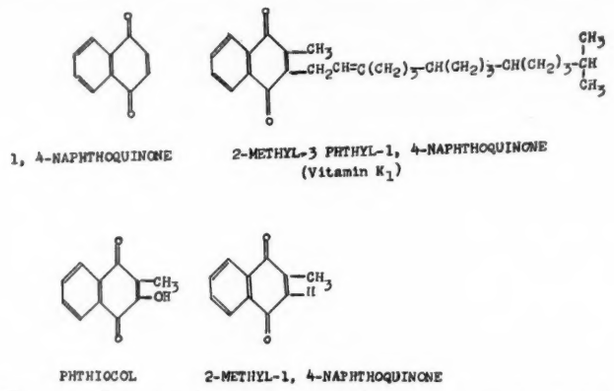

FIG. 1. Structural formula of vitamin K_1 and related compounds.

PHYSIOLOGY

Vitamin K and Prothrombin. Just what happens to the vitamin after its absorption from the intestinal tract is not known. Vitamin K is not a component part of the prothrombin molecule and the interaction of tissues, or more specifically liver, is necessary for the conversion of vitamin K to prothrombin. The rapidity of action of vitamin K as reflected by the response in prothrombin formation, suggests an enzymatic reaction. A deficiency of vitamin K results in a corresponding fall in plasma prothrombin until a critical level is reached when spontaneous hemorrhages ensue.

Prothrombin and Liver. Animal experiments indicate that tissue injury in general is followed by a prompt and significant fall in the plasma prothrombin. The liver differs from other tissues in that it has been found to be essential for the formation of prothrombin. On the basis of this fact there is an explanation for the increased incidence of postoperative bleeding following difficult operations on the biliary tract despite the fact that there had been no previous bleeding tendency. It also emphasizes the necessity of determining potential bleeding by prothrombin estimations, which, like potential shock, can be detected only by laboratory methods. One can readily realize how a nonbleeder with a plasma prothrombin of 30 or 40 per cent of normal, having a 25 per cent drop immediately after operation, might fall below the critical level and uncontrollable bleeding take place during the critical three to seven days postoperatively when there is a dietary deficiency as well.

As to the fate of prothrombin in the body aisde from its rôle in the coagulation of the blood little is known. Andrus, Lord and Kaner have demonstrated that the blood in pulmonary veins has approximately 10 per cent less prothrombin than the blood in the pulmonary arteries, thus indicating that there is some destruction or loss of prothrombin in the pulmonary circulation.

The available evidence points to a continuous and relatively rapid disappearance of prothrombin from the circulation and concurrent formation of prothrombin which occurs mainly, if not exclusively, in the liver.

Vitamin K Deficiency Syndromes. Since a deficiency of vitamin K is reflected in the plasma prothrombin, the deficiency syndromes may be theoretically determined from any condition likely to result in a hypoprothrombinemia. Such a condition may result from any of the following: (1) Lack of vitamin K in the diet; (2) absence of bile salts from the intestinal tract; (3) grossly deficient absorptive surface of the intestinal tract; (4) marked liver

damage, and (5) marked and repeated hemorrhage.

CLINICAL USE OF VITAMIN K

Vitamin K may be used in any case presenting evidence of a hypoprothrombinemia with or without the hemorrhagic tendency if not due to extensive liver damage, in which case it is not contraindicated, but has been shown to yield little or no response. In the absence of obstructive jaundice, external biliary fistula or an abnormal intestinal surface, the prothrombin response to vitamin K may be interpreted as a test of liver function. Inability to correct a hypoprothrombinemia by vitamin K therapy is indicative of extensive liver damage.

Vitamin K is being used prophylactically in obstetrical practice. The prothrombin level of infants born of mothers treated with vitamin K has been found to be higher than in the nontreated group.

Sources of Vitamin K. The average human diet contains adequate amounts of vitamin K for normal requirements if it can be absorbed and utilized. Rich sources of natural vitamin K are spinach, kale, cabbage, egg yolk, rice bran, tomatoes, casein, alfalfa, carrot tops, soy-bean oil, pig, dog and beef liver, chestnut leaves, oat shoots, hemp seed and putrefied fish meal; also products of metabolism of certain bacteria, e.g., Bacillus tubercle, Bacillus coli and Staphylococcus aureus.

MODE OF ADMINISTRATION

Natural vitamin K concentrates may be given by mouth or intramuscularly in oily solutions. If given by mouth, bile salts must be administered simultaneously to insure adequate assimilation.

The synthesis of vitamin K active substances has almost entirely supplanted the use of the natural vitamin and for obviously good reasons. The synthetic compounds are all water-soluble in varying degrees and can be administered orally, subcutaneously, intramuscularly, intraperitoneally and intravenously without bile salts. Intravenous administration produces a marked response in a few hours whereas the other routes may take twelve to twenty-four hours.

The average dose of 2-methyl-1, 4-naphthoquinone is 1 to 3 mg. daily. Much larger doses, however, can be given with safety if indicated. It is supplied in 1 mg. tablets and in oil solutions for oral use. It is not as water-soluble as other synthetic quinones. At the present time there are numerous vitamin K-active products on the market suitable for parenteral administration.

It is common practice now in some obstetrical centers to prescribe routine prophylactic doses of vitamin K to mothers in the form of 1 mg. tablets weekly during the last month of pregnancy and 1 mg. daily for the last two to three days antepartum. In addition, from 0.35 to 1 mg. daily doses of vitamin K are given to infants in the first week or two after birth.

Vitamin K and Transfusions (Bank Blood). It is important to bear in mind that the prothrombin concentration of bank blood diminishes rapidly after the third day and is practically useless as a source of prothrombin after the ninth day of storage.

TOXICITY

No toxic manifestations have been noted from tremendous doses of the natural vitamin K. Some anemia and general depression of the hematopoietic system has attended the use of very large doses of the synthetic products, including 2-methyl-1, 4-naphthoquinone. The therapeutic ratio, however, is so very high that one may use it without hesitation in the recommended clinical doses.

SUMMARY

Although the exact mechanism of blood coagulation is not fully understood, it is generally accepted that prothrombin, thromboplastin and calcium interact to form thrombin which combines with fibrinogen to form fibrin. The only physiological

anticoagulant known is heparin, which is not found in circulating blood in any appreciable amount.

Vitamin K apparently is a precursor or possibly an enzyme in the formation of prothrombin, which is a product of liver metabolism. Absorption of the natural fat-soluble vitamin K from the intestinal tract requires the presence of adequate bile salts and a normal intestinal mucosa. Its utilization after assimilation depends on the presence of healthy liver tissue for the formation of prothrombin.

Synthetic vitamin K products, generally more potent than the natural vitamin, are naphthoquinone derivatives, most of which are water-soluble and can be administered parenterally.

Vitamin K is of greatest value in correcting the abnormal blood coagulation due to hypoprothrombinemia as a result of obstructive jaundice or biliary fistulas. It is also useful in correcting hypoprothrombinemia of the newborn.

All patients submitted to biliary tract surgery in the presence or absence of jaundice should have prothrombin determinations and vitamin K therapy preoperatively and postoperatively. The plasma prothrombin response to vitamin K therapy in the presence of a hypoprothrombinemia may be used as a sensitive liver function test.

In the recommended therapeutic doses vitamin K and its related synthetic products are not toxic.

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This (generalized polyneuritis) may be brought about by vitamin deficiency, chemical poisoning, virus infection, or bacterotoxic agent.

SULFATHIAZOLE IN THE TREATMENT OF APPENDICEAL PERITONITIS*

A. F. JONAS, JR., M.D.
Instructor in Surgery, University of Nebraska
OMAHA, NEBRASKA

THE introduction of chemotherapy has stimulated great interest in the possibility of treating various forms of peritonitis with the sulfonamide agents. The report of Ravdin, Rhoads, and Lockwood[1] on the sulfanilamide treatment of appendiceal peritonitis is in point.

In the fall of 1939 we began to treat occasional cases of widespread peritonitis or peritoneal contamination with sulfathiazole. These cases, chiefly multiple gunshot wounds of the colon and perforated peptic ulcers of long duration, did so well clinically that we started the occasional use of the drug in cases of peritonitis due to perforated appendicitis. Since March 1, 1940, every patient having perforation of the appendix has promptly received sulfathiazole treatment. When possible the drug has been given by mouth—for adults of average size an initial dose of 4 Gm. followed by 1 Gm. every four hours. When complications such as vomiting or when the use of duodenal suction have prevented oral administration, the sodium salt has been given intravenously—for adults an initial dose of 4 Gm. followed by 2 Gm. every eight hours. Due to rapid excretion of the drug and to individual variations in excretion, frequent blood level determinations have been made and the dose tempered so as to maintain a level of 6 to 10 mg. per cent. Most of the patients have shown crystals of sulfathiazole in their urines but this has constituted no contraindication to continuation of therapy. A few patients have developed transitory oliguria or anuria with elevation of the blood nonprotein nitrogen, but these manifestations have cleared in every case within thirty-six hours of onset and following the liberal administration of intravenous glucose and saline.

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* From the Department of Surgery, Johns Hopkins Hospital and University, Baltimore, Maryland.

200 concurrent cases of this sort would color favorably the mortality rate. In no other detail than the use of sulfathiazole has the treatment differed from that reported by Stafford and Sprong[4] from this hospital. In their series of 479 similar cases occurring during the preceding eight years, there were forty-eight deaths, yielding a mortality rate of 10.02 per cent. In the current series of sixty-one cases, there were two fatalities, a gross mortality of 3.28 per cent. One of these patients, a negro boy of 12 years, came to the hospital on the ninth day of his illness with advanced generalized peritonitis. He died after a prolonged course of eight weeks during which several additional operations were done for subphrenic abscess, pelvic abscess and empyema. At autopsy he showed at least five distinct abdominal abscesses lying chiefly along the root of the mesentery and between loops of intestine. The other fatality occurred in a white woman who reached the hospital on the fifth day following perforation. She seemed nearly moribund but operation was performed under local anesthesia, her appendix removed and her peritonitis drained. She died five hours after operation but since she received one intravenous dose of sulfathiazole, must rightfully be included in this report. Were she not, the gross mortality would be 1.64 per cent.

Since sulfathiazole is the least toxic of the three sulfonamides in common use and also has the widest range of activity, it is logical and successful, too, to employ it in the treatment of peritonitis of appendiceal origin. Its value in the treatment of concomitant postoperative pneumonia is an additional reason for its use.

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SULFATHIAZOLE IN THE TREATMENT OF APPENDICEAL PERITONITIS*

A. F. JONAS, JR., M.D.
Instructor in Surgery, University of Nebraska
OMAHA, NEBRASKA

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OVARIAN LESIONS SIMULATING APPENDICITIS*

EDWARD F. MCLAUGHLIN, M.D.
Surgeon, Nazareth Hospital
PHILADELPHIA, PENNSYLVANIA

THE ovarian lesions which most often give symptoms suggestive of appendicitis are ruptured Graafian follicles, follicle and corpus luteum cysts and bleeding corpora lutea. The syndrome that is set up is of fairly frequent occurrence; the possibility of its occurrence is even more likely, since a slight deviation from the normal physiological changes of any menstrual cycle may give rise to it.

Excessive hemorrhage from a normally rupturing follicle at the time of ovulation probably accounts for the mid-period type of pain—the mittel-schmerz. Bleeding from an insecurely "plugged" corpus luteum or the rupture of a cystic corpus luteum is the commonest type and occurs usually between the time of ovulation and of menstruation. Breaking of the more established so-called simple cysts which may have arisen from atretic follicles or persistent corpora lutea also gives rise to symptoms of appendicitis and may occur at any time in the menstrual cycle. The peritoneum is irritated in any of these instances by the escaping blood. Perhaps it is irritated at times by the cystic fluid. The reaction is mild—an active hyperemia—although at times some true inflammatory changes have been noted.

The number of reported cases of this "disease" is small. Articles by Hoyt and Meigs[1] Manizade,[2] Sexton,[3] Harris and Groper,[4] Weil,[5] McLaughlin,[6] Guy and Rotundi,[7] and Castallo[8] cover the field fairly well as far as literature on the subject goes. It is deemed worth-while, therefore, to report some additional cases, to discuss their relation to appendicitis and to evaluate the results of operative treatment in preventing further attacks.

PRESENT STUDY

Forty nine patients* with ovarian lesions simulating appendicitis were studied. Eight were nonoperative cases (Case I†). Seventeen showed unruptured cysts at operation (Case II). (In this second group it is believed that cyst ruptures had occurred previously but operation happened to come at the end of an attack or in an "interval stage.") In three more both appendicitis and cyst rupture existed simultaneously (Case III). The remaining twenty-one cases showed freshly ruptured cysts of the ovary (Case IV).

All patients were white. The white predominance, evident in other reports as well as this, is so constant that one may almost say the condition is limited to white women. The patients' ages varied from thirteen to forty-two, the average being 24.3; 69.3 per cent of the women were single.

Symptoms and Signs. The symptoms and signs of cyst rupture follow in sequence the pathologic happenings in the abdomen and are in direct proportion to their severity. They arise from (1) the local irritation caused by the escaping blood or cyst fluid; this gives rise to most symptoms; (2) the irritation of more distant areas of peritoneum as when the escaped fluid makes its way to the upper abdomen or under the diaphragm; (3) possibly by visceral response to the irritation of its

* The patients studied, other than the author's, were under the care of several different Philadelphia surgeons; Doctors W. B. Swartley, C. F. Mitchell, W. E. Lee, E. B. Hodge, S. D. Weeder, R. Alston and J. Toland, who have kindly permitted the use of their case histories.

† Case histories illustrating the four types of patients will be found at the end of the paper.

* Read before the April Meeting, 1941, of the Philadelphia Academy of Surgery.

covering peritoneum, and (4) again possibly by absorption through the peritoneum of hormones from the escaped fluid or from an underlying etiologic hormonal stimulus itself. This hormonal stimulus, whatever be its source, accounts for the spotting which occurs in some of the cases (12 per cent).

It may also make a woman more sensitive to pain stimuli as is described in the related state of "premenstrual tension."

Among the signs and symptoms we find that pain, mild but definite, was common to all but one patient and was located in the lower right quadrant in 69 per cent of instances. It was never in the lower left quadrant alone, but was "abdominal" four times and epigastric five times. In but 18 per cent of the cases, did the onset resemble the generalized onset of acute appendicitis pain. Nausea was experienced by about half the patients (54 per cent) while only 19 per cent vomited. Lower right quadrant tenderness accompanied the other symptoms 96 per cent of the time but rigidity could be demonstrated in just 13 per cent of the examinations. The tenderness could only be gotten on so-called "deep" palpation in 20 per cent of the cases. One finds that the onset of symptoms was sudden in twenty-two cases (45 per cent) and slow in twenty-seven (55 per cent). They began on the average 16.9 days after the onset of the preceding period and 10.9 days before the next one started. There was a semblance of regularity to the recurrence of attacks in but eleven patients (22 per cent) while thirty-five (71.4 per cent) had had previous regular or irregular attacks; the classical regularity of the Mittle-schmerz was not very evident. All but six of the patients (12 per cent) had regular menstrual periods (88 per cent).

The record of temperature, pulse, leucocyte count and polymorphonuclear percentage is best expressed in Table 1. In a word, these values in all our ordinary cases were at the high level of normal. In the three cases in which acute appendicitis was associated with the ovarian lesion, the average values were temperature 100.2°F. pulse 119, white blood count 16,900, polymorphonuclears 79.5 per cent—much higher than in the general group.

Fig. 1. Graafian follicle bulging from ovarian surface; ovarian tissue over follicle thinning out in preparation for rupture.

Examination of the pelvis by rectum or vagina was not done in two-thirds of the cases (65.3 per cent), a valuable maneuver having thus been omitted. When it was done (seventeen times) tenderness was revealed ten times and cystic ovaries were palpated three times.

Diagnosis. Appendicitis was considered as a diagnosis in all the cases. It was first choice in 56.6 per cent and secondary in 43.4 per cent. Ovarian lesions were considered as an underlying cause 77 per cent of the time and were the primary diagnosis in 41 per cent of cases. In two of the three cases of appendicitis with associated cyst rupture both conditions were considered preoperatively.

Operative Findings. In the forty-one patients operated upon, ruptured cysts were found twenty-one times (51 per cent), unruptured cysts in seventeen (41 per cent) and ruptured cysts plus acute appendicitis in three (7.5 per cent). The left ovary was

involved seven times (17 per cent), the right ovary thirty-one times (73 per cent), both ovaries once and in one instance the ovary involved was not designated. Old blood, or bloody fluid was found in nineteen cases (46.3 per cent). In some of the others there seemed to be an amount of clear fluid greater than normal. Adhesions were noted in four cases (7.9 per cent); in one instance these adhesions blocked the tubes.

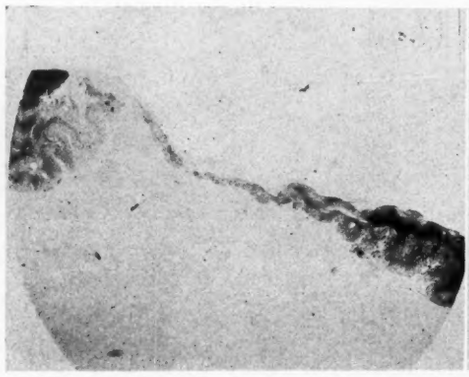

Fig. 2. Section at site of a rupture. The surface covering has gotten down to an almost one-layer thickness. Early luteinization of lining cells has begun.

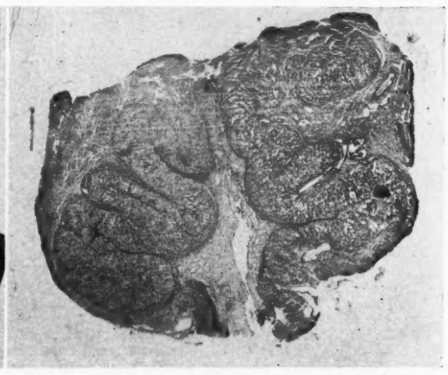

Fig. 3. Early corpus luteum showing hematoma-like center. This had blown out its "plug" and was found bleeding at operation.

Table I

AVERAGE VALUES FOR THE ITEMS LISTED IN THE DIFFERENT GROUPS OF CASES STUDIED

	Temperature °F.	Pulse	Leucocytes	Polymorphonuclears
Total	98.8	89	10,500	71.7
Ruptured cyst	98.8	89	9,700	71.4
Cystic ovaries	98.6	86	10,700	69.6
Nonoperative	98.5	85	10,600	76.2

36 per cent had counts of 10,000 or over.
34 per cent had temperatures of 99°F. or more.

Operative Treatment. Appendectomy was done on all the operated patients. Partial oophorectomy with oversewing was done in thirty-seven (90 per cent). Oophorectomy was performed three times (7.5 per cent) and salpingo-oophorectomy once (2.5 per cent). There was no mortality in the present group.

DISCUSSION

Differential Diagnosis. Ovarian follicles and simple cysts probably come and go without giving any appreciable symptoms 90 per cent of the time. When they do cause trouble, it often resembles appendicitis so closely that any thought of delaying operation would be folly. Yet on the other hand, in many instances there are recognizable differences and if these are carefully weighed, the diagnosis of the ovarian lesion can be made with a sufficient degree of accuracy and a nonoperative course pursued. In general the differences can best be expressed by tables. Table II shows the main differences from acute appendicitis and Table III those from recurrent appendicitis.

Table II

ESSENTIAL DIFFERENCES BETWEEN CYSTS AND ACUTE APPENDICITIS

Acute Appendicitis	Ruptured Cyst
1. Pain general, later localizing	Pain local and remains so
2. Nausea and vomiting	Nausea less frequently; vomiting unusual
3. No discharge	Spotting occasionally
4. Tenderness, definite McBurney's	Tenderness slight; lower
5. Rigidity	Absence of rigidity
6. Temperature and pulse elevated	Temperature and pulse normal
7. White blood cells and polymorphonuclears increased	White blood cells and polymorphonuclears about high normal

Acute Appendicitis. From acute appendicitis the points of difference are essen-

tially as follows: The onset in acute appendicitis is usually gradual and general, later localizing in the lower right quadrant. The onset in the kind of cyst cases comparable to acute appendicitis is often sudden. But sudden or slow it almost invariably begins as a localized pain and remains so or becomes more generalized later. Tenderness is much more acute in appendicitis and one does not need to do a "deep" palpation to get it. It centers roughly around McBurney's point. Tenderness in cyst rupture is absent or of a mild degree. It is not definitely centered but is found lower down than in appendicitis. One does not often get rigidity after cyst breaking; nausea occurs occasionally and vomiting almost never. In contrast, the usual history of acute appendicitis contains a record of both nausea and vomiting following the onset of pain. Fever, pulse rise, leucocytosis and increase in percentage of polymorphonuclear cells characterize appendicitis. In the other cases one often finds a normal temperature and pulse rate or perhaps a slight rise above normal and the white cells and the differential count are usually at high normal limits.

Table III

DIFFERENTIAL POINTS IN CYST RUPTURE AND RECURRENT APPENDICITIS

Recurrent Appendicitis	Ruptured Cyst
1. Irregularity of occurrence	Sometimes regular
2. Unrelated to menstrual cycle	Mid-period or latter half of cycle
3. Right side	Occasional left sided attack
4. No discharge	Spotting or discharge with attack
5. Occasional acute attacks	No typical appendical attack
6. No masses	"Phantom" tumor

Pelvic Appendicitis. A very dangerous condition in any case, pelvic appendicitis may be said to mask itself by simulating ovarian disease rather than the reverse. For too long a time the initial signs and symptoms, mild enough to suggest very strongly a cyst rupture, will persist in their mildness because of the pelvic location of the appendix and the distinguishing points of rigidity, fever, tachycardia, leucocytosis, etc., may appear only after appendiceal rupture has taken place. The pelvic findings of tenderness and possibly a small mass are almost useless. It may be said that the patient with appendicitis is distinctly the sicker one, but this will not make the differential diagnosis. The obvious answer is that one should operate if there be any reasonable suspicion of appendicitis existing in the pelvis.

Chronic or Recurrent Appendicitis. In this type of appendicitis and in those cases of cystic disease resembling it, symptoms are mild and immediate decision as to operation is not imperative so that one may take more time to arrive at an accurate differential diagnosis. In this group of cases accurate differentiation is possible if one has the patience to study them over a sufficient period of time, that is, through several menstrual cycles. First, an accurate history is important. The woman patient is rare who will volunteer any information as to when her attacks of pain have come in relation to the menstrual cycle. She does not think of them in that light and neither do many physicians. If it can be elicited that they come with a fair degree of regularity at mid-period time (halfway between menses), a very valuable clue has been gotten as to their source. Most cases of cystic rupture do not have this characteristic of regularity, however. But most patients will give the history that their attacks occasionally shift to the left side (if one keeps the patient under observation long enough to find this out). While it is true that rupture of cysts in the left ovary frequently give rise to right-sided symptoms, yet there will certainly be some attacks entirely centering in the lower left quadrant.

The occurrence of mid-period spotting accompanying lower abdominal pain is about the most pathognomonic sign of follicle cyst rupture. It is a very helpful symptom when it occurs but it is recorded rather infrequently (12 per cent of present cases). In some patients there occurs a

whitish, or yellowish, or even watery discharge with their pain but this is usually overlooked and only of slight value in differentiation if present.

Recurrent appendicitis is in reality a succession of mild attacks of acute appendicitis so we should expect the exhibition of fairly classical symptoms during some one attack. Certainly the chance that temperature, pulse and leucocyte count will be higher is much greater than in the ovarian conditions. Nausea and vomiting are, of course, more likely to occur when the appendix is involved.

Curtis has described what he calls the "phantom tumor," a simple cyst of the ovary which ruptures between examinations, so that in successive examinations no sign of the previously described pelvic mass can be felt. This point can be made use of in a patient suspected of having recurrent pain from cyst rupture, by having her report for a pelvic examination every few days through a menstrual cycle. The examinations may reveal that one ovary enlarges before her attack of pain occurs and is decreased in size afterward.

Diagnosis at Operation. Since the existence of a ruptured cyst is so often either not considered or only secondarily thought of, one must say a word about the identification of such a condition when the abdomen is opened. First, it is probably true that in many instances ruptured retention cysts are overlooked through failure to examine the pelvis or by making a very cursory pelvic examination, not visualizing the ovaries. Through a McBurney incision it is difficult accurately to feel both ovaries and it is almost impossible to expose the left one. Through a small or high right rectus incision it is again difficult truly to appraise the pelvic viscera. At times an appendix, whose outer coat is hyperemic due to the irritating fluid in the peritoneal cavity, is taken to be the sole source of trouble, is removed and the abdomen closed. Ignorance is bliss in such a case until the patient returns a few months later wanting to know why attacks of pain similar to those suffered preoperatively are coming back just as often and just as severely.

Upon opening the peritoneal cavity one may find nothing abnormal. Even the ovaries may seem within normal limits. Closer inspection may reveal a small cyst that has a dark spot on its surface as the only remains of an opening through which fluid escaped. These are the cases in which the patients symptoms have been present for some days and by the time of actual operation the "evidence" may be gone.

At the other extreme, one may open the abdomen and find definite hemorrhage and an increased volume of intra-abdominal fluid. The visceral surfaces may appear injected but I have never seen the process advanced to a degree where plastic exudate was found. The ovary may show a cyst wall with a rent in it. There may be a persistant trickle of blood from this or the opening may be sealed over with a clot. Some cysts will be filled with blood and have a plug of coagulated material in a small round hole on the surface. At times blood has been seen coming past the edges where such a plug was not tight. At a later stage one may find the cyst closed and shrunken with only a few small clots of blood in the pelvis to indicate what has taken place.

Postoperative Diagnosis. Even with a ruptured cyst oversewn, the appendix, incidentally removed, and the abdomen closed one is not yet able to rest on his diagnosis. For the obliging pathologist often reports "low grade appendicitis," "fibrous appendicitis," etc., with "fragments of ovarian tissue resembling corpus luteum." The more convenient diagnosis of "appendicitis" is used in the record room and another case of cyst rupture which was taken for appendicitis and which led to a laparotomy not absolutely necessary, is effectively buried.

Treatment. It is believed from the data presented that there are those cases which can be safely and with a sufficient degree of accuracy distinguished from appendicitis.

If a diagnosis of the ruptured cyst syndrome can be made, no operative treatment is indicated unless the symptoms prove too distressing or if there is evidence of too much blood loss. It is well to remember, however, that once a patient is put down as suffering from the ovarian cyst rupture syndrome every attack of abdominal pain, especially that localizing in the lower right quadrant, is not assuredly from this same cause. Such a patient should be examined in each attack to eliminate if possible the question of appendicitis. One such patient appeared in our series in which after repeated attacks of intermenstrual pain, one attack differed from the others. Operation was done and an acute appendicitis was found associated with a leaking corpus luteum cyst.

Where there is a reasonable doubt as to whether or not a given patient suffers from appendicitis of cyst rupture, let it be clearly understood that operation is mandatory.

FOLLOW-UP

The immediate problem is solved by operative removal of the leaking cysts. But the underlying urge remains. There is no assurance that the lesion will not again arise in the same or the opposite ovary. However, the main question is: "How often do clinical symptoms recur?" In searching for an answer twenty-eight of the thirty-one eligible operative patients in this series were followed and 78.8 per cent had no recurrence. The literature furnishes little help on this point and so letters were addressed to men interested in the subject. Meigs[9] recalls no patient, to whom the situation was properly explained, coming back with the same complaint unremedied. Guy[10] recalls but three or four patients who had symptoms persist after operation. Weil[11] had nine cases recur out of fifteen followed. Castallo[12] tells of four personal cases with no recurrences. Harris[13] had recurrences in but two of fifty cases and believes that "the operative resection of organized corpus luteum or follicle cyst from the ovary is practically a cure" and thinks there is a higher incidence of recurrence in nonoperated patients. Totaling all the available figures (Table IV), we may say that 82 per cent of ninety-seven cases showed no return of clinical symptoms which could be attributed to a repetition of the cyst rupture syndrome. This is comforting to the conscientious surgeon who finds no acute appendicitis upon opening an abdomen but a ruptured cyst and who often wonders whether he is doing the patient any good by resecting the cyst which is the immediate offender. It would seem from the figures collected that the patient was being distinctly benefitted by the cyst removal.

CASE REPORTS

CASE I. M. McH., No. 49, came home from work with a persistent pain in the lower right side, fearing she had appendicitis. She had had previous attacks during the few months preceding, each time shortly before a menstrual period. The present attack began twelve days before the expected period and was accompanied by some spotting of blood. Her temperature was 98.6°F., and pulse 72. Tenderness in lower right quadrant was practically nil. She was observed for twenty-four hours, by which time symptoms had subsided.

CASE II. D. W., No. 37, a woman of twenty-five had about six attacks of lower right quadrant pain which gave symptoms for a day or so. These usually came near mid-period or in the early part of the latter half of the cycle. Usually no fever accompanied the pain. The patient desired to have "something done" and operation was performed away from the time of an attack. Unruptured retention cysts of both ovaries were found and excised; the appendix was normal.

CASE III. M. B., No. 20, nineteen years of age, had sudden pain in the right lower quadrant while stepping into a car. Her period was due in ten days. Within three hours she was hospitalized and there was tenderness but no rigidity in the lower right quadrant. She was nauseated and vomited. Her temperature was 100°F., pulse 120, white blood cells 19,400, polymorphonuclears 78. Cyst rupture was suspected and she was allowed to go till morning when operation was thought advisable with

tenderness still persisting. A ruptured cyst and an acute pelvic appendix were found.

Case iv. I. G., No. 8, a nurse of twenty, at mid-period time had a sudden pain in the lower right quadrant. It remained localized to that area. There was no nausea or vomiting. Her temperature was 98.2°F., pulse 92, white blood cells 8,400, polymorphonuclears 84. Tenderness and some rigidity were noted in palpating the lower right quadrant of the abdomen. Operation was advised to be on the safe side and upon opening the abdomen blood-tinged fluid was seen and a small oozing cyst of the right ovary exposed. The cyst was resected, the exposed ovarian tissue oversewn and the appendix removed.

SUMMARY AND CONCLUSIONS

1. The ovarian lesions which most often simulate appendicitis are ruptured follicles, follicle and corpus luteum cysts and bleeding corpora lutea. Forty-nine such cases are reported.

2. A certain number of these may be clinically differentiated from appendicitis and a nonoperative course pursued.

Table iv
RESULTS OF FOLLOW-UP STUDIES ON CYST RUPTURE CASES

	Cases	Recurrences	Symptom Free	Cure, Per Cent
Harris	50	2	48	96
Weil	15	9	6	40
Castallo	4	0	4	100
Present series	28	6	22	78.6
Total	97	17	80	82

NON-OPERATIVE

Patient	Number	Date	Hospital
C. S.	Private Patient		
M. McL.	Private Patient		
E. M.	.....	4-4-41	Municipal
I. S.	.....	4-14-41	Municipal
M. F.	.....	4-8-41	Municipal
C. Y.	12104	10-28-40	Germantown
F. B.	Private Patient		
M. McH.	Private Patient		

Table iv—(*Continued*)
CYSTIC OVARIES

Patient	Number	Date	Hospital
D. S.	35928	10-1-39	Germantown
V. K.	25830	2-8-39	Germantown
M. D.	33785	3-22-39	Germantown
M. P.	40154	10-8-40	Germantown
G. S.	35245	7-29-39	Germantown
E. McE.	35615	9-4-39	Germantown
C. H.	32952	1-2-39	Germantown
R. B.	36295	11-4-39	Germantown
D. R.	35980	10-6-39	Germantown
M. F.	36567	11-30-39	Germantown
A. M.	25541	4-26-40	Germantown
D. S.	1803	2-26-41	Nazareth
D. W.	1756	2-19-41	Nazareth
R. S.	323	5-31-40	Nazareth
G. M.	421	6-20-40	Nazareth
H. B.	256	5-15-40	Nazareth
G. K.	214	5-5-40	Nazareth

RUPTURED CYSTS

Patient	Number	Date	Hospital
E. H.	10349	10-12-39	Chestnut Hill
L. N.	10350	3-23-39	Chestnut Hill
C. McK.	32582	11-22-38	Germantown
N. B.	5540	12-31-38	Chestnut Hill
M. G.	11631	9-19-40	Chestnut Hill
F. E. E.	35835	10-3-39	Germantown
W. O'D.	34469	5-25-39	Germantown
I. G.	28942	3-22-39	Germantown
M. R.	35296	8-3-39	Germantown
T. N.	23682	9-16-36	Germantown
A. G.	21062	10-11-39	Germantown
C. McG.	36135	10-21-39	Germantown
V. F.	35656	9-7-39	Germantown
J. S.	35793	9-19-39	Germantown
A. G.	5161	4-12-40	Germantown
M. B.	33360	2-1-40	Germantown
M. C.	36283	11-2-39	Germantown
R. L.	32936	1-1-39	Germantown
K. McC.	28623	1-3-41	Germantown
M. B.	10076	9-7-39	Chestnut Hill
G. G.	1662	2-1-41	Nazareth
S. C.	1703	2-15-41	Nazareth
R. D.	1947	3-20-41	Nazareth
E. B.	1877	3-13-41	Nazareth

3. If the ovarian lesions be found when the abdomen is opened, resection of the cystic portion will give freedom from further clinical symptoms in 82 per cent of cases.

4. The final word should be an admonition not to hesitate to open the abdomen

in those cases in which any doubt exists as to the possibility of appendicitis.

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TUMOR of the ovary may be solid or cystic, benign or malignant, small or huge. Primary ovarian tumor can occur at any time: before puberty, during menstrual life, or after menopause. Metastatic tumor of an ovary is not uncommon, especially from the gastro-intestinal tract, breast, cervix, or uterus.

THE PRINCIPLES OF SURGICAL TECHNIC*

WITH COMPARISON OF RESULTS OBTAINED WITH FINE SILK, FINE CHROMIC CATGUT AND LARGE CATGUT (CHROMIC AND PLAIN)

LIEUT. COMDR. CHARLES H. LUPTON, M.C., U.S.N.R.
Surgeon, Norfolk Naval Hospital
NORFOLK, VIRGINIA

THE purpose of this article is to stress the importance of observing certain well defined principles of surgical technic, and to make a comparison of the results obtained when using (1) *fine silk*, (2) *fine chromic catgut*, and (3) *large catgut* (chromic and plain).

This series consists of 400 unselected and consecutive cases in which the peritoneal cavity was opened. There are 125 consecutive patients in each of the *fine silk* and *large catgut* (chromic and plain) groups, and 150 consecutive patients in the fine chromic catgut group.

The instructions given to the interns on the use of and the clinical investigation of fine chromic catgut* were as follows:

1. This investigation is being conducted to determine: (a) If as satisfactory results could be obtained when using fine chromic catgut as were obtained when using fine silk†; and (b) to make a comparison between the results obtained when using fine chromic catgut with a refined technic, and large catgut (chromic and plain) as ordinarily used.

2. The skin, subcutaneous tissues, muscles and fascia must be completely covered with laparotomy pads or towels immediately after making the incision, and they should be kept covered until they are ready to be closed. After the peritoneum is opened the moist laparotomy pads or towels should be attached to it.

3. Small hemostats, small forceps, small needles and small needle holders should be used.

4. The inclusion of large amounts of tissue when ligating and transfixing bleeders should be avoided.

5. Careful hemostasis is one of the most important factors in avoiding postoperative complications.

6. It is suggested that the following sizes of fine chromic catgut be used: (a) No. 0000 should be used for ligating and transfixing small vessels. (b) No. 000 should be used for ligating a moderately sized vessel. (c) When a moderately large or a large vessel is to be ligated, use No. 00 or No. 0. (d) For closing the peritoneum and transversalis fascia, No. 0 is advisable. (e) For suturing muscle No. 0000 or No. 000 should be used. (f) For closure of fascia use No. 0, except in long upper abdominal incisions or where there is much tension it may be necessary to use No. 1. (g) Under no circumstances should a size larger than No. 1 be used for any purpose. (h) Only the fine chromic catgut which has been furnished by one manufacturer will be used in this investigation.

7. A square knot should be used for the majority of ligatures of small vessels, but for larger vessels a surgeon's knot or a triple throw knot tied square will be necessary, the latter being preferable to the surgeon's knot when using catgut. "Granny knots" must be avoided. The sutures should be cut closer to the knot than they would if large catgut were used, but the length of the suture from the knot should

* From the surgical services of the Norfolk General Hospital and Norfolk Naval Hospital.

† Principles of surgical technique with particular reference to the use of silk. *Am. J. Surg.*, 45: 309–315, 1939.

* Read before the Seaboard Medical Association (N. C. and Va.), December 3, 1941. The opinions expressed in this article are those of the writer and are not to be construed as reflecting the views of the Navy Department.

depend upon the size of the suture, the tension it is under and the importance of the knot.

8. Records of maximum postoperative temperatures, evidences of infections or disturbances of primary healing, estimation of the amount of abdominal distention and the general condition of the patients should be carefully made.

9. *Infections.* (a) Whenever there is any disturbance of primary union, it should be recorded. (b) Serum suggests minor infection. (c) Pus indicates major infection. State whether slight, moderate or severe.

The same technic was attempted in both the fine silk and fine chromic catgut groups; however, in the large catgut (chromic and plain) group, there was not as much refinement of technic in regard to the use of small hemostats, small needles, clamping small amounts of tissue, keeping the edges of the wound covered while operating, etc. In other words, the technic in the large catgut group was similar to that employed by the average surgeon using large catgut.

It should be the aim of the surgeon to improve his technic, not only in order to secure more recoveries, but also to lower his morbidity rate. The surgeon's knowledge of the principles of surgical technic, as well as his surgical philosophy, will be indicated by his percentage of infections in clean surgical cases, and by the incidence of low postoperative temperatures with resultant low morbidity and low mortality rates.

The teachings of Dr. Elliott C. Cutler and Dr. Robert Zollinger have been a stimulus toward the development of a more refined surgical technic. The result has been a lower morbidity rate with fewer complications; therefore, the postoperative care has not played so important a rôle as it did previously.

In order to re-emphasize the importance of (1) complete examination of the patient, (2) adequate preoperative preparation, and (3) a more refined surgical technic, I wish to repeat a statement made in a previous article.* "There has been voluminous literature during the past two decades or more on the importance of preoperative preparation and postoperative care. I do not desire in any way to detract from the importance of all that has been written; in fact, I think it would be well to re-emphasize and concur in the importance of careful preoperative and postoperative measures. But this point I do wish to make: if there has been proper preoperative investigation and preparation, and a careful technique—including gentleness and careful hemostasis during the operation—then there will be fewer postoperative complications, and the postoperative care will not play so important a part."

LOW POSTOPERATIVE TEMPERATURES

The significance of low postoperative temperatures should be re-emphasized. It is surprising to find so little literature on this subject. The one thing that usually has the most significant meaning on the clinical record is the postoperative temperature. If this has remained low, it would certainly be reasonable to assume that no serious complication had arisen, eliminating emboli and allied conditions. The more refined the surgical technic, the lower will be the postoperative temperature and the morbidity rate.

The factors in producing low postoperative temperatures and more satisfactory postoperative courses are: (1) asepsis and certain measures employed to minimize wound infections; (2) careful hemostasis; (3) gentleness, and (4) correct use of proper suture material.

ASEPSIS AND CERTAIN MEASURES EMPLOYED TO MINIMIZE WOUND INFECTION

Every surgeon attempts to use an aseptic technic. This has been emphasized so much, and its importance is so well known to surgeons everywhere, that it seems needless to discuss this subject again, except to

* *Am. J. Surg.*, 45: 309–315, 1939.

re-emphasize that the surgeon must be constantly on guard to make certain that there will be no break in the aseptic technic.

Many measures are employed to minimize wound infections. I have not attempted to list all of those measures, in fact I have listed only those measures, most of which are part of the aseptic technic which I wish to emphasize because they are not always strictly observed. In discussing *certain measures employed to minimize wound infections* it is realized that these measures are employed by the vast majority of surgeons. It is only because some surgeons do not employ all of them or are somewhat careless in their employment, that it seems necessary to stress certain phases of their importance here.

A. Adequate Sterilization of the Hands and Arms of the Operative Team. The adequate sterilization of the hands and arms of the surgeon and of the operative team is a most important part of aseptic technic. It is impossible completely to sterilize the hands and arms for more than a short period of time even with the best methods in use. Some methods which are thought to be satisfactory do not completely sterilize the surface of the skin for even a short period. In other words, positive cultures will be obtained in many cases when cultures are taken immediately from the nails, after manicuring the nails, scrubbing the hands and arms with soap and water for ten minutes and then immersing the hands and arms in one basin of alcohol (70 per cent). If immersions in two separate basins of alcohol are made, the percentages of positive cultures will be very much reduced. During a time when there was an epidemic of acute respiratory infections, using the method of preparation described above in a small series of cases the following results were obtained:

After using alcohol (70 per cent), 100 per cent of the cultures were positive; after using two separate basins of alcohol (70 per cent), 10 per cent of the cultures were positive. When substituting an aqueous solution of zephiran (1-1000) for the alcohol, all cultures were negative. The more careful the manicuring of the nails and the scrubbing of the hands and arms, the lower the percentages of positive cultures will be, regardless of the antiseptic used. It is realized that when there are infections of the nose and throat of members of the operative team the percentage of positive cultures will necessarily be high, and it is also realized that no definite conclusions can be drawn from a small series of cultures; nevertheless from this limited experience an aqueous solution of zephiran (1-1000) for one minute, or a weaker solution of 1-3000 for three minutes appears to be a splendid antiseptic for the hands and arms. The stainless tincture of zephiran (1-1000) may be used for arm and hand soaks. It must be remembered that it is absolutely necessary to remove all soap before using zephiran. When using an aqueous solution of zephiran there is no drying or irritation of the skin; in fact, when using the wet-glove technic the hands are often in as good a condition after operating as they were before. The wet-glove technic, when using an aqueous solution of zephiran, is superior to the dry-glove technic.

B. Adequate Sterilization of the Operative Field. The operative area should be properly shaved and thoroughly cleansed with soap and water, taking care to remove all soap. When in the operating room, the operative area should first be cleansed with ether and alcohol. When a tincture of zephiran is used, make two applications and rub it gently into the skin of the operative area. The alternate rubbing of the skin of the operative area, first with an aqueous solution of zephiran (1-1000) and then with alcohol (70 per cent), using six sponges of each, beginning along the line of the proposed incision and working outward toward the periphery of the operative field, is one of the best methods of preparing the operative area.

C. Proper Sterilization of Sutures, Instruments, Linen, Supplies, etc. It is the

responsibility of the surgeon to see that all sutures, instruments, linen, supplies, etc., are properly sterilized. He should familiarize himself with the improved methods of sterilization of instruments. Cultures should be made frequently from the supplies and instruments to be certain that adequate sterilization has been carried out.

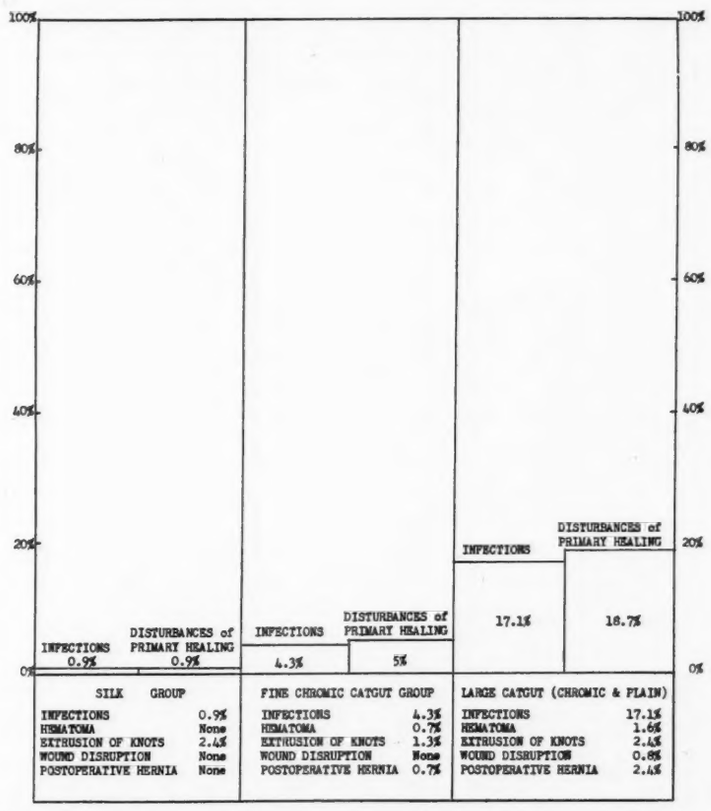

FIG. 1. Graph showing the comparison of infections, etc., in a series of fine silk, fine chromic catgut and large catgut (chromic and plain) cases.

While it has been proved by certain investigators that catgut was not always sterile, it is not believed that catgut is often a source of wound infection at the present time.

D. Adequate Masks. The average masks are not adequate for the purpose for which they are intended. They are not large enough to prevent the escape of moisture, neither do they completely filter all bacteria in the moisture from the nose and throats. It must be recognized that surgeons with equally refined technic may not always obtain similar results. One surgeon's nose and throat may harbor highly virulent organisms, particularly the hemolytic streptococcus or the hemolytic staphylococcus aureus. Naturally, the surgeon who harbors those highly virulent organisms cannot obtain as satisfactory results as the surgeon who is not a carrier of such organisms. The nose and throat is a more frequent source of wound infections than is generally realized.

After using the various types of masks, including the "deflector types," it seems that the type of mask described by Dr. DeTakats and Dr. Jesser* is the most efficient and satisfactory. This type of mask with a few minor changes has been used for a few months and it appears to be more suitable than any type previously used. It is made of one layer of Canton flannel 9 by 7½ inches (these dimensions should be reduced one-half inch for nurses), which is

* *Surg. Gynec. & Obst.*, June, 1941.

placed between two layers of crinoline (discarded from adhesive plaster). It is sewed twice (one-half inch apart) around

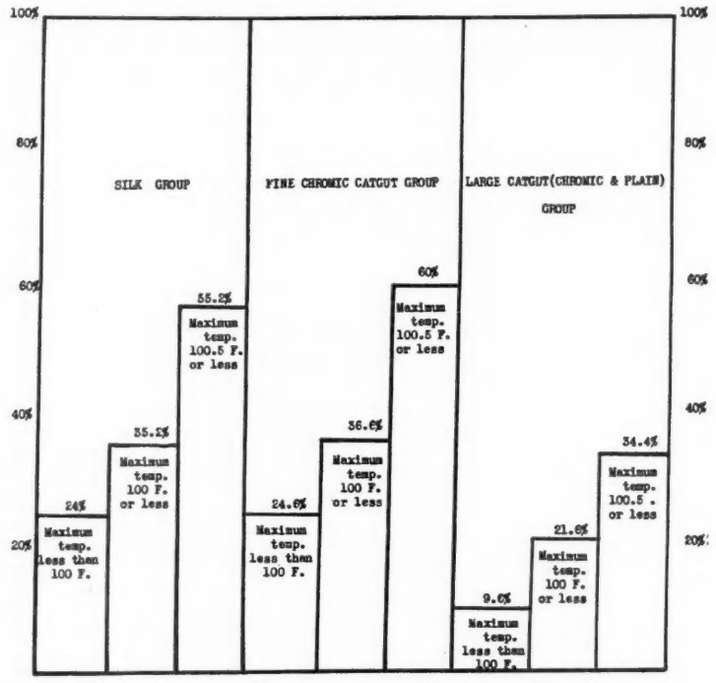

FIG. 2. Graph showing the comparison of low postoperative temperatures in a series of fine silk, fine chromic catgut and large catgut (chromic and plain) cases.

source. However, agitation of floor dust should be avoided by the use of too vigorous air currents. Air-conditioning is to be

the edges, and then diagonally across from the corners to prevent the Canton flannel from rolling or becoming detached. Two three-fourth-inch tucks are taken at each of the ends, and two, three-eighth-inch tucks are taken at the bottom of the mask. A piece of one-half-inch tape, the length of the mask, is sewed along the upper border; then a piece of one-half-inch tape 40 inches long is sewed along each of the upper and lower borders of the mask. A small aluminum metal strip is inserted between the two pieces of tape along the upper border of the mask, the purpose of which is to make the mask fit around the nose and face. The mask is not tight across the mouth, although it fits well around the face.

E. Air-Conditioning and Special Bactericidal Radiant Energy. With the frequent change of air in the operating room, through air-conditioning, the number of organisms in the air is reduced, thereby lessening the danger of infection from this especially recommended for the operating room in warm climates.

Special Bactericidal Radiant Energy. The attempted sterilization of the air in the operating room as recommended by Hart is believed to be of value, particularly when all other precautionary measures have been employed and infections are greater than ordinarily expected.

F. Minimize External Sources of Infection after the Operation. Many measures can be taken to minimize external sources of infection after the operation. The nose, mouth and throat of those doing dressings, adjacent patients, visitors, as well as the patient himself are often external sources of infection after the operation, particularly those infections occurring late. When late infections occur, all possible sources of infection should be investigated and eliminated if that is possible. Patients developing respiratory infections should be transferred from surgical wards promptly; when

that is not feasible, they should be isolated. Those having respiratory infections should not do dressings, but if for any reason they do, masks should be worn.

One of the important factors in preventing the development of postoperative pulmonary complications, particularly atelectasis, is adequate aeration of the lungs.

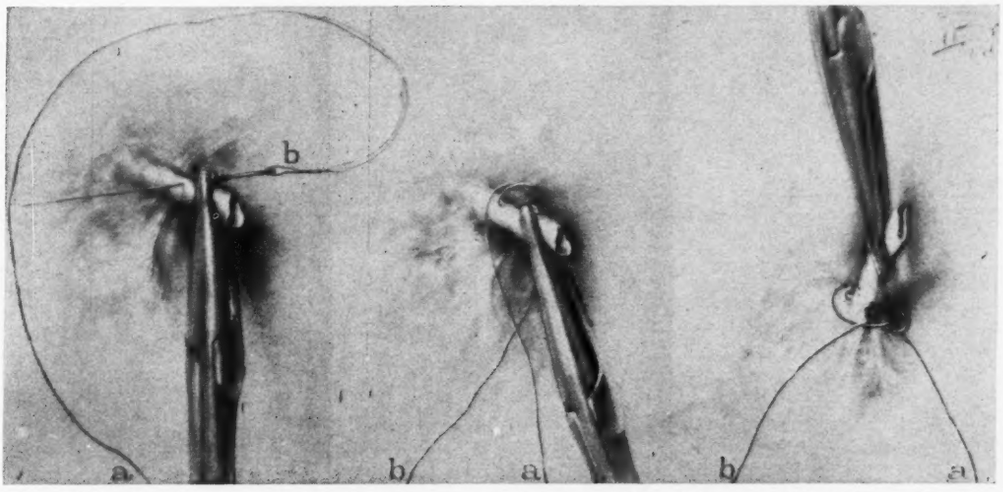

Fig. 3. The ligation of an isolated vein or artery by transfixion. The vessel has been twisted to prevent bleeding from the needle-prick. (From Halsted, William Steward. Ligatures and suture material. *J. A. M. A.*, 60: 1119–1126, 1913.)

Clean surgical cases should be dressed before infected cases. Stitches should be removed carefully, and care should be taken to avoid contamination when doing dressings.

G. Special Postoperative Measures to Minimize Wound Infections. Many postoperative measures are in use which are of vital importance to the patient. No attempt will be made to enumerate all of these measures; in fact, only those measures which are frequently neglected will be mentioned.

Postoperative pulmonary complications (many are due to emboli and a refined technic reduces their incidence) are often a direct or indirect factor in the development of wound infections. Every precaution should be taken to keep these postoperative complications at a minimum. Complete examinations should be made prior to the operation to make certain that no respiratory infection is present in cases scheduled for elective operations. Should respiratory infections be present in cases requiring emergency operations, determine their nature and take prompt postoperative measures for their correction.

While either helium-oxygen (helium 80 per cent; oxygen 20 per cent) or carbon dioxide in oxygen, (carbon dioxide 5 per cent) should be used for aeration of the lungs, neither should be depended upon alone. Of more importance is the frequent *deep breathing* (at least six deep breaths every half hour when awake) throughout the first three days of the postoperative period. Frequent deep breathing will be even more beneficial after spinal anesthesia than it will after general anesthesia, as the patient will be able to co-operate immediately after the operation. It is essential that patients be reminded frequently of the importance of deep breathing, otherwise they will neglect it, as deep breathing often increases their discomfort. The frequent change of position after operation should go hand-in-hand with deep breathing.

Atelectasis should be treated promptly by aeration of the lungs with carbon dioxide-oxygen and by placing the patient on the uninvolved side for certain periods. When the symptoms become distressing, with cyanosis and dyspnea, an oxygen tent should be employed. Many consider the bronchoscopic aspiration of the mucous

exudate as the treatment of choice, and it is especially recommended for extensive atelectasis or whenever symptoms are

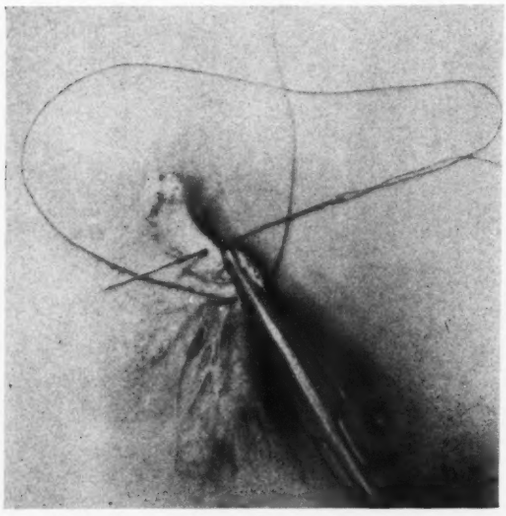

Fig. 4. The usual method of controlling hemorrhage from one or more vessels by transfixion. (From Halsted, William Steward. Ligature and suture material. *J. A. M. A.*, 60: 1119–1126, 1913.)

persisting after the above measures have been instituted. When respiratory infections occur after operations, they should be treated promptly, one of the sulfonamide group of drugs, particularly sulfathiazole, often being indicated.

Any condition which prolongs the convalescence or lowers the patient's resistance, may be a factor in the development of wound infections or complications. Therefore, it is essential that all measures be taken to avoid or minimize the occurrence of those conditions. Prostigmine is useful in preventing or decreasing distention, and it is usually given as a routine measure, unless contraindicated.

In prolonged illnesses or when duodenal suction has to be continued over a considerable period, a proper fluid balance should be maintained, with adequate electrolytes and vitamins. Blood transfusions are often necessary, or the administration of plasma may be indicated in order to obtain an adequate serum protein level. In the event of pronounced hemorrhage, plasma should be given at once to restore blood volume and a blood transfusion given as soon as it is available to replace the loss of cellular elements of the blood.

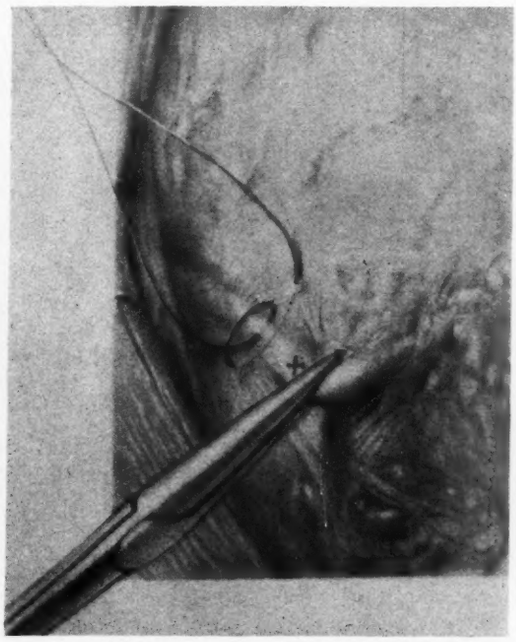

Fig. 5. Ligation by transfixion of nonisolated vein, to be divided at x. The clamp is on the tumor side of the vessel. (From Halsted, William Steward. Ligatures and suture material. *J. A. M. A.*, 60: 1119–1126, 1913.)

Wound repair is retarded by either a deficiency of proteins or a deficiency of vitamin C; therefore, a deficiency of either may be a definite factor in the development of wound disruption or postoperative hernia. Wound repair is also retarded by a high fat diet.

CAREFUL HEMOSTASIS AND GENTLENESS

When there has been proper preliminary investigation and adequate preoperative preparation, excepting a gross break in technic, then *careful hemostasis* is considered the most important factor in avoiding postoperative complications. It is even more important than gentleness. The importance of both careful hemostasis and gentleness can not be stressed too much, and they should go hand-in-hand in a refined technic.

PROPER SUTURE MATERIAL

Silk. In regard to the proper ligature-suture material, I would list fine black

twisted silk as best suited for clean surgical cases. Fine black twisted silk prepared according to the instructions given under "Silk Technic" is economical. Serum-proof silk has no advantage over twisted silk which has been waxed, and it is much more expensive. Silk can be used for interrupted sutures in slightly infected or in potentially infected cases, if extreme care is taken to avoid contamination; but in these cases it is advisable to use catgut sutures adjacent to the drain, whenever drainage is necessary. The use of silk in these cases should never be attempted by anyone who is not entirely familiar with all the details of the silk technic. Silk should not be used where gross contamination is unavoidable.

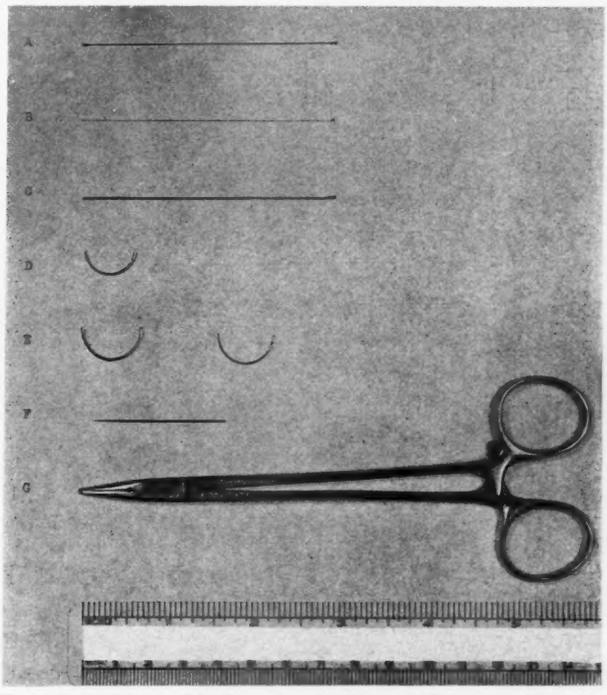

Fig. 6. A, No. 4 black twisted silk; B, No. 000 chromic catgut; C, No. 2 chromic catgut; D, No. 3 French needle; E, No. 3 Kelly intestinal needle and No. 12 Ferguson needle; F, milliner needle; G, small needle holder used in the silk technic.

Principles of the Silk Technic

The following are some of the principles of the silk technic: No. 4 black twisted silk is ordinarily used for all purposes. The silk is wound around a board of sufficient length, so that the silk strands when cut across once will be approximately 18 inches long. The silk strands are then dipped in melted bone-wax. The excess wax is wiped off and the silk is autoclaved.

Another method of preparing the silk is to wind it around a board long enough so that the silk strands will be the desired length when cut across once; however, the silk is not cut until the time of the operation. The silk is waxed on the board and autoclaved. Small rubber tubing split in half is attached to the ends and across the sides of the boards. Shambaugh recommends adding an equal amount of vaseline to the beeswax. Starting the knot made with twisted silk which has been treated with only beeswax has a tendency to become untied. This danger is diminished when vaseline has been added to the beeswax. Shambaugh's experimental findings have been my clinical impressions since adding vaseline to the bone-wax.

Silk should not be sterilized several times as it loses its strength from repeated sterilizations. A small half-circle No. 2 or 3 French needle is used, except in gastro-

intestinal work in which a straight intestinal needle (milliner) is usually preferable. There are occasions when a No. 3 or 4 half-circle Kelly intestinal needle or a number 12 half-circle Ferguson needle may be substituted for the French needle, particularly when sewing through thick, dense fibrous tissue. It is best not to use the same silk suture more than once in a French needle as it may become frayed; however, this fraying could be avoided to a great extent if one were careful always to thread the French needle near the end of the silk strand, and never to pull the silk through the needle. A small needle holder must be used with French needles. The hemostats used for clamping the vessels must be small. One should attempt to clamp only the vessels; if any tissue is included in the clamp, it must be the smallest amount possible. There must be minimal tissue injury with careful sharp dissection. Gentleness must be observed and the maintenance of maximum blood supply should be the aim throughout the operation.

The strangulation of large amounts of tissue must be avoided, but all bleeding must be controlled immediately. Transfixion of ligatures should be frequently employed. The silk suture, the finest that will furnish the necessary strength, must be cut at the knot. The surgeon's knot is most satisfactory for silk; but where there is much tension or when ligating moderately large or large vessels, another throw (tied square) on the surgeon's knot will be necessary. When using silk, the single square knot may not be adequate for holding, especially if there is any particular tension. The weakest part of the suture is at the knot. The skin, subcutaneous tissues, muscles and fascia should be covered at all times until they are ready to be closed; when the peritoneum is opened it is attached to the laparotomy pads used to cover the edges of the wound. Silk sutures should be interrupted, except in the peritoneum where they may be continuous. However, continuous sutures must never be used in infected or in potentially infected cases. When closing the peritoneum the sutures should be placed so the edges of the peritoneum will extend upward into the wound, in order that there will be no raw surface extending within the abdomen. The careful closure of all layers is most important, but no layer is probably as important as the peritoneum and transversalis fascia. The subcutaneous fat should be closed with interrupted silk sutures in order to close the dead space. A subcutaneous suture is used for the purpose of almost approximating the skin edges, and they should be placed so the knot will be underneath. The bite should be taken a short distance from the edge of the wound and should include only the deeper layers of the skin. These subcutaneous sutures are important; they help to keep tension off the skin sutures and aid in producing narrower scars. The interrupted skin stitch is considered the most suitable of all skin stitches. No suture should be placed under tension if it is possible to avoid it. Skin sutures should be just tight enough to approximate the skin edges. In order to avoid trauma, incisions should be of sufficient length to give adequate exposure. Care should be taken in removing sutures and in changing dressings. Silver foil is used to cover the incision; it helps to prevent contamination and infection.

COTTON

I have had only a limited experience with cotton as a ligature-suture material, but from this experience and from the literature, it would appear to be comparable to silk. It seems probable that cotton as a ligature-suture material will find a more general use in surgery as soon as its qualities become better known. Cotton is economical and so far the reports on its use as a ligature-suture material have been extremely favorable. Neither silk nor cotton should be used as a suture material except by those who have been trained in the silk technic or unless they fully understand and will carry out the rigid rules employed in the silk technic. In other

words, neither silk nor cotton should be employed in a manner similar to that employed when using large catgut; otherwise difficulties will surely be encountered. Certainly there should be no place in surgery for large sizes of nonabsorbable sutures, particularly using large nonabsorbable sutures throughout an operation.

FINE CHROMIC CATGUT

This clinical investigation of fine chromic catgut and the various articles appearing in the literature seem definitely to indicate its superiority to large catgut (chromic and plain). When it is considered that fine chromic catgut lasts longer in the tissues than the larger sizes, and any size of chromic catgut lasts much longer than plain catgut; and also taking into consideration the fact that plain catgut causes much greater reaction of the tissues—with delayed wound healing, then there is definite reason for using the smallest chromic catgut suture that has sufficient tensile strength for the period of healing. It is unusual for No. 0 chromic catgut (twenty day—medium) of the brand used in this investigation not to have adequate tensile strength. However, it may occasionally be necessary to use No. 1. The same results will not always be obtained with the same sizes of different brands of catgut because of the different methods employed in their manufacture. A suture may have adequate strength for the initial period of healing, but not enough strength for the entire period of healing. When using fine chromic catgut the sutures should be placed closer together than when using large sizes. The area of induration along the incision where fine chromic catgut has been used is less than it is when large catgut has been employed.

There was only one patient in the group of fine chromic catgut cases, in which the tensile strength of No. 0 chromic catgut (twenty day—medium) was not adequate for the entire period of healing. This patient had a cholecystectomy performed in 1935, and in 1936 he developed a ventral hernia in the region of the operative scar. In 1937, the hernia was repaired but it recurred in 1939. Examination of this patient revealed a moderately large ventral hernia along the upper right rectus in the region of the operative scar. The hernia was repaired, using No. 0 chromic catgut (twenty day—medium) as interrupted mattress sutures in the peritoneum and fascia, with the fascia being overlapped. The wound became infected, with the first sign of the infection becoming noticeable on the tenth postoperative day. The infection was not severe, as the drainage did not total more than a tablespoonful. The hernia recurred a few weeks after he got out of bed. This patient's poor health and his lack of care for himself after being allowed out of bed, are additional factors which probably had a definite bearing on the recurrence, although it is believed that the infection was the greatest factor. Several recurrent inguinal hernias are included in this group of fine chromic catgut cases, without any evidence thus far of recurrences.

When considering the reaction caused by plain catgut, the short duration it holds in the tissues, and also taking into consideration the fact that fine chromic catgut can serve better as ligature-suture material in any location than plain catgut, with the possible exception of ligating bleeders in the skin, there would appear to be an extremely limited field for the use of plain catgut in surgery. Fine chromic catgut as a subcutaneous suture should not be larger than size No. 0000, especially if the suture is near the skin. As long as physicians and hospitals continue to order the larger sizes of suture material—whether it be catgut or silk—the manufacturers will continue to produce them. It is the responsibility of the surgeon to see that he gets the correct suture material and that it is the proper size. There certainly will be less plain catgut used when the facts relating to its disadvantages, and those concerning the superiority of fine chromic catgut become better known.

CORRECT USE OF PROPER SUTURE MATERIAL

In regard to the correct use of the proper suture material, it is recommended that the silk technic be employed when using silk, cotton or fine chromic catgut. Those who lack training in the silk technic should not use silk or cotton unless they use the smallest sizes, take extreme care to avoid contamination and follow the most rigid rules of technic. To those who lack training in the silk technic, it is recommended that they use fine chromic catgut. The finer the suture material used the more refined the technic becomes. For the average surgeon, fine chromic catgut appears to be the best suture material for general use at the present time.

REPORT

I am well aware of the fact that definite conclusions can not be drawn from the number of patients in this series; however, the series is large enough to justify the forming of certain impressions. This series consists of unselected and consecutive cases in each of the three groups, and the primary purposes of this report are to compare the differences in infections, postoperative temperatures, etc., when using fine silk, fine chromic catgut and large catgut (chromic and plain).

In each of the three groups the following types of operations are included: appendectomy, herniorrhaphy, cholecystectomy, exploratory laparotomy and different gastro-intestinal procedures. The fine silk and large catgut groups included in addition, splenectomy, hysterectomy and various operative combinations upon the internal female organs.

More appendectomies and herniorrhaphies are included in the fine chromic catgut group, as a majority of the operations in this group were performed upon a younger age group of male patients. As the lowest temperatures are usually obtained in abdominal surgery when there has been either an appendectomy for chronic appendicitis or a herniorrhaphy for uncomplicated inguinal hernia, any difference existing between the three groups in regard to obtaining low postoperative temperatures would certainly be in favor of the fine chromic catgut group. However, many emergency operations are included in the fine chromic catgut group, particularly operations for acute appendicitis, some being perforated and several appendices being gangrenous; therefore, in regard to obtaining a clean wound, any difference existing between the three groups would be in favor of the fine silk and large catgut groups. The percentage of infections in operations for inguinal hernias is ordinarily rather high, but no infection occurred in either the fine silk or fine chromic catgut groups when operating for the repair of inguinal hernias.

Fine Silk Group. In some cases in the fine silk group, No. 1 chromic catgut was used to close the peritoneum; catgut was also used primarily in the pelvic part of operations upon the internal female organs, and in wounds adjacent to the drains. One brand of black twisted silk (champion) was used entirely in the fine silk group, No. 4 being used throughout, except for No. 7 which was occasionally used in suturing the fascia. The principles of the silk technic which have been described were observed in all cases in the silk group. Silver foil was used to cover the incisions in all cases in this group.

Infections. There were thirteen cases which were drained in the fine silk group, but there was no evidence of infection of the wound in any of these cases except immediately adjacent to the drain, and all of these drainage cases healed within a reasonable time.

There was only one infection in the clean cases in the entire fine silk group, and that occurred in a baby ten days old who had an infected umbilicus when he was operated upon. It is believed that the umbilicus was the source of the infection. There was no instance of either serum or hematoma in the fine silk group.

The late extrusion of silk knots occurred in three cases which had been drained (two cholecystectomies and one appendectomy). The wounds in all three cases had completely healed by the twentieth postoperative day. There was an extrusion of one silk knot in one case two months after the wound had healed, and an extrusion of two silk knots in the second and third cases about six weeks after the wounds had healed.

	Per Cent
Infections	0.9
Hematomas	0
Disturbances of primary healing	0.9
Wound disruption	0
Postoperative hernia	0
Extrusion of knots	2.4

Postoperative Temperatures. When using silk and following the principles of the silk technic, if the postoperative temperature goes above 100.5°F., one should look for complications. They will not always be present, but when employing silk and rigidly following the principles of the silk technic, postoperative temperatures are usually low, and a rise above 100.5°F. often indicates that something is wrong. The maximum postoperative temperature in the patient having the least elevation of temperature in the fine silk group was 98.8°F., and the operation was inguinal herniorrhaphy.

Clean surgical cases which usually run the highest postoperative temperatures are: hysterectomies (and various operations upon the internal female organs, particularly when there is infection present), cholecystectomies and operations upon the gastrointestinal tract. The hysterectomies and other operations upon the internal female organs with their tendency to develop infection of the urinary tract, and cholecystectomies were responsible for the majority of cases whose maximum postoperative temperatures were above 100.5°F.

	Per Cent
Maximum postoperative temperature less than 100°F.	24
Maximum postoperative temperature 100°F. or less	35.2
Maximum postoperative temperature 100.5°F. or less	55.2

Distention. It is difficult or practically impossible to determine definitely the amount of postoperative distention. Any statement regarding the amount of distention would necessarily be an estimate; nevertheless, I believe that distention was considerably less in both the fine silk and fine chromic catgut groups than it was in the large catgut (chromic and plain) group. The use of prostigmine is believed to have been a definite factor in decreasing the distention in the fine chromic catgut group, as it was used routinely in about one hundred cases, but it could not have been a very deciding factor in the fine silk group as it was not used in more than twenty cases. Prostigmine, pitressin and duodenal suction were used only occasionally in the large catgut (chromic and plain) group.

FINE CHROMIC CATGUT GROUP

In the fine chromic catgut group, only one brand of catgut (Curity—medium—twenty day) was used and the sizes varied from No. 0000 to No. 0, except in ten cases No. 1 was used instead of No. 0. In this fine chromic catgut group, silk was used as a serosal suture in gastrointestinal anastomosis. When performing operations on the gastrointestinal tract, it is advisable to cover the area immediately surrounding the actual site of the operation with laparotomy pads moistened with an aqueous solution of zephiran in order to minimize the possibility of contamination from intestinal contents. The pads are discarded as soon as the anastomosis is completed. A technic equivalent to the silk technic was employed in all cases in the fine chromic catgut group, except silver foil was not available for appendectomy incisions when drainage was not employed. While no figures can be given from this series on the

importance of silver foil in helping to prevent contamination and infection, I am of the opinion that it is a definite factor.

Infections. There were nine cases which were drained in the fine chromic catgut group, but there was no evidence of infection of the wound other than immediately adjacent to the drain, except in one case and then the slight infection extended only a short distance along the incision on each side of the drain.

There were six infections in the clean cases in the fine chromic catgut group, neither of which was serious, nor was hospitalization delayed more than a few days because of the infections. Four of the infections occurred in appendectomy wounds; one in a herniorrhaphy wound for recurrent ventral hernia (reported above) and another in a herniorrhaphy wound for incarcerated epigastric hernia, the peritoneum of the excised sac being inflamed clinically and verified by pathological report. This patient with the incarcerated epigastric hernia, had some inflammation of the skin and all underlying tissues including the peritoneum of the sac at the time of the operation. Since this was a case of infection it actually should not be included in a group of clean cases and would not, except for the fact the wound was not drained. There was one small hematoma in the fine chromic catgut group of cases, but the wound healed promptly without gross evidence of infection. The appearance of the infection in the appendectomy wounds occurred on the tenth day (postoperative) in two cases, and on the twelfth postoperative day in two cases. There was no case with serum that did not sooner or later show gross evidence of pus. The late extrusion of knots occurred in two cases; one knot in each case being extruded about six weeks after the wounds had healed.

	Per Cent
Infections	4.3
Hematomas	0.7
Disturbances of primary healing	0.5
Wound disruption	0
Postoperative hernia	0.7
Extrusion of knots	1.3

Postoperative Temperatures. When using fine chromic catgut and following the principles of the silk technic, if the postoperative temperature goes above 100.5°F. one should look for complications. A rise above 100.5°F. often indicates that something is wrong, as it does in the case of fine silk.

There was no case in the fine chromic catgut group in which the maximum postoperative temperature was less than 99°F., but there were three cases (two appendectomies and one inguinal herniorrhaphy) in which the maximum postoperative temperature did not exceed 99°F.

	Per Cent
Maximum postoperative temperatures less than 100°F.	24.6
Maximum postoperative temperature 100°F. or less	36.6
Maximum postoperative temperatures 100.5°F. or less	60

Distention. In the fine chromic catgut group the number of cases with minimal distention closely paralleled those in the group in fine silk cases.

LARGE CATGUT (CHROMIC AND PLAIN) GROUP

In the large catgut (chromic and plain) group, the sizes varied from No. 00 to No. 2, the larger sizes being used most frequently, and different brands of catgut were used. There was not the refinement of technic which was employed in the fine silk and fine chromic catgut groups; in other words the technic employed was similar to that employed by the average surgeon using large catgut. Silver foil was not used on the incisions in this group.

Infections. In the large catgut group there were fourteen cases which were drained. In five of these drainage cases the incisions became infected; that is, there was evidence of infection of the wound in addition to the infection immediately adjacent to the drain. The remaining nine cases showed no infection except where the wound was drained. The fact that five out of fourteen drainage cases in this group showed considerable infection of the inci-

sion in addition to that adjacent to the drain, would seem to indicate that silver foil is of importance in keeping these incisions clean except where they are drained.

In the clean cases in the large catgut (chromic and plain) group there were infections of the wounds in sixteen instances: three cases of a small amount of serum which soon healed without gross evidence of pus, five cases of serous drainage which soon became purulent, and eight frankly purulent cases from the very beginning of the infection. One of the patients whose infection was purulent became extremely ill as a result and it was six weeks before the wound healed. There was a moderately severe infection which occurred unusually late, the first evidence of the infection appearing on the twenty-third postoperative day. The wound in this case drained four weeks. In addition there were five cases in this group which developed hematomas, three of which soon developed gross evidence of pus. There were three patients which developed postoperative hernias in this group. One postoperative hernia (or recurrent inguinal hernia) followed the repair of an inguinal hernia which developed a moderately severe infection of the wound; another postoperative hernia developed after an operation upon the internal female organs, in which drainage was necessary and the wound became infected in addition to that adjacent to the drain and the third postoperative hernia developed in a patient who had had two previous operations: one a low midline incision for salpingo-oophorectomy and appendectomy, and the other a long upper right rectus incision for cholecystectomy.

There was one patient who developed a disruption of the entire wound down to the fascia on the tenth postoperative day. This patient had had very slight drainage at the lower end of the incision (low midline) but it had practically ceased, and she was to be discharged from the hospital on the day the disruption occurred. The disruption occurred about two hours after the skin stitches had been removed, and followed immediately after an attack of unexplained vomiting. There was a secondary closure of this wound one day after the disruption and the wound had healed by the thirtieth postoperative day. The remarkable thing about this disruption is the fact there was complete disruption down to the fascia, without any evidence then or later of the fascia, muscles or peritoneum being affected.

There were extrusions of knots in three cases after the wounds had apparently healed. The extrusion of the knots occurred from one to four weeks afterward.

	Per Cent
Infections	17.1
Severe infection (3 cases)	2.7
Moderate infection (4 cases)	3.6
Slight infection (9 cases)	8.1
Serum (3 cases)	2.7
Hematomas	1.6
Disturbances of primary healing	18.7
Wound disruption (incomplete)	0.8
Postoperative hernia	2.4
Extrusion of knots	2.4

Postoperative Temperatures. In the large catgut (chromic and plain) group there was no case in which the maximum postoperative temperature did not exceed 99°F. It will be noted that there is a marked difference between the percentage of low postoperative temperatures in the fine silk and fine chromic catgut groups and the large catgut (chromic and plain) group. The lower the postoperative temperatures, the more comfortable the patients and the fewer the complications.

	Per Cent
Maximum postoperative temperature less than 100°F.	9.6
Maximum postoperative temperature 100°F. or less	21.6
Maximum postoperative temperature 100.5°F. or less	34.4

Distention. Distention was considerably more marked and troublesome in the large catgut (chromic and plain) group. While the more frequent use of prostigmine and duodenal suction in the fine silk and particularly in the fine chromic catgut groups were definite factors in relieving or

decreasing distention, nevertheless, the impression has been gained that the distention was certainly less in these two groups than in the large catgut (chromic and plain) group, when neither of these measures was employed.

CONCLUSIONS

1. The more refined the surgical technic, the smoother will be the convalescence with fewer complications, regardless of the suture material employed.

2. Low postoperative temperatures throughout the convalescence usually mean low morbidity and low mortality rates.

3. Fine silk is slightly superior to fine chromic catgut in the following respects: (a) wound infections, (b) slightly less tissue reaction, and (c) fewer wound disruptions and postoperative hernias.

4. Fine chromic catgut is superior to fine silk in the following respects: (a) It is more suitable for infected cases and for general use, and (b) it is easier to employ.

5. Fine chromic catgut when employed according to the principles of the silk technic is superior to large catgut (chromic and plain) as ordinarily used in the following respects: (a) wound infections, (b) low postoperative temperatures, (c) wound disruption and postoperative hernia, (d) postoperative complications, (e) less tissue reaction, with more rapid healing of the wounds, and (f) greater holding strength over a longer period of time, when it is most needed.

6. Fine chromic catgut is preferable to plain catgut as a ligature-suture material in abdominal surgery, with the possible exception of ligating bleeders in the skin.

7. Large sizes of suture material should not be used throughout an operation.

8. When employed according to the principles of the silk technic, either fine silk or fine cotton appears to be the suture material of choice in clean surgical cases. However, for the average surgeon, fine chromic catgut appears to be the best suture material for general use at the present time.

9. Incisions should be of sufficient length to give adequate exposure.

10. Deep breathing and frequent change of position, when properly carried out during the first few days of the postoperative period, are factors in preventing postoperative pulmonary complications, particularly atelectasis.

11. Hemorrhage, trauma and infection are important factors in producing postoperative discomfort and complications.

12. Careful hemostasis is one of the most important factors in avoiding postoperative complications.

13. To be able to operate quickly and at the same time to observe certain well defined principles of surgery, such as careful sharp dissection, careful hemostasis and gentleness is a highly skilled accomplishment, but the surgeon should never attempt to hurry through an operation in a good risk patient. For the extra time spent in employing a careful technic, the surgeon will be well repaid with lower morbidity and mortality rates.

I wish to express my appreciation to The Lewis Manufacturing Company for their generosity in furnishing an adequate supply of fine chromic catgut for this clinical investigation.

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REIMPLANTATION OF THE TIBIAL SPINE IN AVULSION FRACTURE OF THE ANTERIOR CRUCIAL LIGAMENT*

W. Russell MacAusland, M.D.
BOSTON, MASSACHUSETTS

ACCURATE reduction of fractures of the tibial spine due to avulsion of the anterior crucial ligament is essential to the preservation of the stabilizing strength afforded by this ligament in the knee joint. That the fragment, when displaced to any appreciable extent, can be accurately replaced by the generally accepted method of treatment is to be questioned. Surgeons for the most part still advise conservative manipulation in fresh fractures, believing that upon extension of the knee, the fragment falls back into its tibial bed. However, not only is it difficult to obtain complete extension of the knee in the presence of the marked distention that accompanies such fractures, but the fragment, displaced and often rotated, cannot be controlled and forced into its bed by extending the joint. Even if extension and replacement were possible, the fragment would tend to be lifted from its bed by the organized blood clot in the fracture cavity.

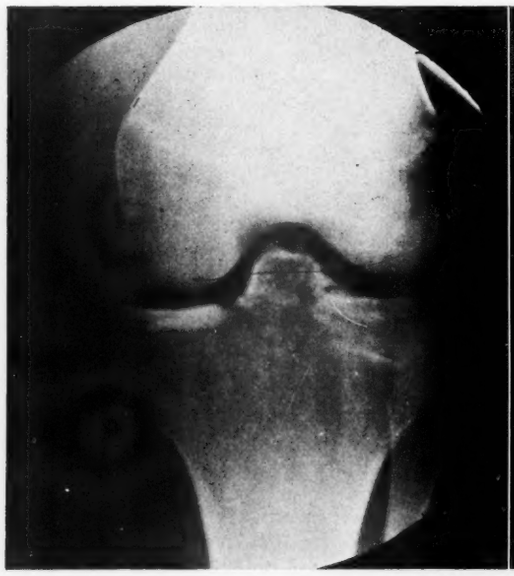

FIG. 1. Avulsion fracture of the entire spine of the tibia with displacement.

FIG. 2. Screw fixation of the fragment three days after the injury.

Avulsion fractures of the tibial spine with displacement are best treated by operative reduction and fixation of the fragment. From time to time operators have attempted to point this out and to suggest methods of fixation. Suturing of the bony fragment in place has been advocated, and a particularly satisfactory method has been suggested by Lee. Another method, which would seem to have certain advantages over the suture procedures, is the fixation of the fragment by means of a screw. This method is a simple one and easily carried out. Through the operative exposure accurate replacement of the fragment is made possible, and by the screw fixation more secure retention of the fragment is insured than by the suture methods. Motion may be safely instituted at an earlier period than following fixation by

* From the MacAusland Orthopedic Clinic, Boston.

sutures, which might give way under tension, and the convalescence is thereby shortened.

Operative Technic of Screw Fixation. The knee is prepared and flexed to a right angle. A tourniquet is applied to the upper thigh.

An incision is made through the skin and fascia, in the midline of the knee, beginning over the quadriceps tendon about three inches above the patella and running down over the patella to a point below the tibial tubercle. The quadriceps tendon and patellar ligament are split, and the periosteum over the patella is incised. The patella is sawed through vertically in the center, and its halves together with the divided quadriceps tendon and patellar ligament are retracted laterally.

The semilunar cartilages are inspected, and if damaged, are removed. The fracture cavity and the surface of the fractured tibial spine are carefully cleaned of blood clots and fibrous strands. The tibial spine is replaced in its bed, and a screw is placed through the attachment of the anterior crucial ligament and the midportion of the fragment and tightly set into the tibia.

The capsule of the joint is closed with fine chromic catgut. The quadriceps tendon, the patellar ligament and the fascia over the patella are sutured with interrupted chromic catgut, and the skin is closed with silk sutures.

The knee is immobilized in a posterior plaster shell in the position of from 10 to 15 degrees of flexion. After ten days contraction of the quadriceps should be practised daily. At the end of three weeks the shell is removed, and the patient acting as his own guide may begin to move the knee gently. Hot fomentations are of benefit at this time.

CASE REPORT

M. S., a girl aged sixteen, injured her left knee in an automobile accident. The roentgenographic examination showed that the entire tibial spine had been avulsed by the anterior crucial ligament. The fragment was well elevated from its tibial bed. (Fig. 1.)

Operative fixation was carried out on the third day after the injury according to the technic that has been described. Damage to the subpatellar fat pad necessitated its removal. (Fig. 2.)

End Result. Four months after the operation, the knee is stable, painless and has a full range of motion. The patient is able to dance and to do everything she wishes.

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Case Reports

TUBERCULOSIS OF THE GREATER TROCHANTER*

WALTER G. STUCK, M.D.
Chief of Orthopedic Surgery,
Robert B. Green Hospital

AND

JOHN J. HINCHEY, M.D.
Resident in Orthopedic Surgery,
Robert B. Green Hospital

SAN ANTONIO, TEXAS

As is generally known, tuberculosis of the shaft of the long bones is relatively rare as it occurs in only 3 per cent of all cases of bone and joint tuberculosis. A quite unusual manifestation is tuberculosis of the upper end of the shaft and greater trochanter of the femur. Myerding and Mroz reported nineteen such cases in 1933 and listed a complete bibliography. In the case we have recently observed there was extensive involvement of the upper end of the shaft of the femur although there was no infection of the hip joint.

Beneath the gluteus maximus muscle there is a large bursa over the lateral aspect of the greater trochanter which seems to be a favorite site for the development of the tuberculous infection. It is from this bursa that the infection may spread until the bone becomes extensively involved. In the cancellous bone of the trochanter spread of the infection takes place easily until there is much destruction of bone. Involvement of the bursa alone is more common in children, while accompanying infection in the bone of the trochanter occurs mainly in adults. Swelling about the trochanter of many months' duration, local nonfebrile fluctuating masses, aching pain, and limp are the most typical signs and symptoms. *X*-rays reveal erosion of bone and occasional sequestra although there may be no bone changes in those cases in which only the bursa is involved.

The most satisfactory treatment of tuberculosis of the greater trochanter is complete excision of the infected tissue and closure of the skin without drainage in order to forestall the dangerous secondary infection or troublesome chronic sinus formation. In our present case it was not deemed wise to close the wound because of the extensiveness of the infection in the bone. Nevertheless, the use of powdered sulfanilamide in the wound prevented the development of secondary infection and the wound healed promptly after the pack was removed.

CASE REPORT

A. O., a fifty-two year old Mexican man was first observed September 8, 1941, because of burning pain in his right hip which he had noticed for eight months. At the onset a hard red spot, the size of a quarter, had appeared in the region of the right greater trochanter. He applied a salve and an abscess formed which had drained off and on ever since.

The patient worked as a ranch hand in Mexico until he was thirty years of age and was a coal miner several years subsequently. In 1922, he was caught in a cave-in of a mine and received a simple fracture of the lower end of the right femur and a simple fracture of the upper end of the right tibia. Four months after this accident a small piece of bone worked out at the medial side of his right knee and was removed. There had been no subsequent drainage, pain or stiffness of the knee. His right leg has been three-fourths inch shorter than the left ever since the accident which had caused a slight limp.

* From the Orthopedic Service of the Robert B. Green (City-County) Memorial Hospital, San Antonio, Texas.

FIG. 1. *X*-ray of hip before operation showing extensive involvement of the greater trochanter with calcified masses about the upper end of the femur.

FIG. 2. *X*-ray of hip after operation revealing removal of all infected bone and most of the calcified areas.

The patient has been married twenty-four years and has had one stillborn child. There was no history of tuberculosis, lues, or other familial disease.

Examination revealed a Mexican adult male of average size who walked with a scarcely noticeable limp. An open sinus about ⅛ inch in diameter was present on the lateral side of the right thigh directly over the greater trochanter. The skin around it was indurated for about an inch in all directions. Six inches distal to the sinus was an indurated reddened area the size of a quarter which had been present two weeks. There was no limitation of motion of the hip joint nor was any tenderness elicited on manipulation or deep pressure over the hip. The right leg was ¾ inch shorter than the left.

Urinalysis was negative. There were 3,840,000 red blood cells with 10.5 Gm. hemoglobin, 5,650 white blood cells with 66 polymorphonucleus and 32 lymphocytes. Kline and Kahn tests were negative.

Smears and cultures from the draining sinus over the trochanter revealed the presence of Staphylococcus aureus.

X-ray revealed an old fracture at the junction of middle and lower third of right femur. There was destruction of the upper end of the femur with loss of the entire greater trochanter and the top of the neck of the femur. There were numerous large, round, calcified masses in the soft tissue surrounding the upper end of the femur. (Fig. 1.) *X*-rays of the chest were negative for evidence of tuberculosis.

On September 20, 1941, under spinal anesthesia a lateral incision was made over the right hip, the gluteus medius and the tensor fascia femoris muscles were separated and the neck of the femur and greater trochanter exposed. Several small pieces of dense, calcified tissue were found completely separated from the shaft and neck. These were removed as were calcified masses in the greater trochanter and upper end of the shaft of the femur. After all necrotic tissue was removed, powdered sulfanilamide was sprinkled in the wound and it was packed with vaseline gauze. (Fig. 2.) Skin edges were brought together loosely. The gauze pack was removed at the end of three weeks and the wound healed promptly in the next three weeks.

Pathological examination of tissues removed revealed giant cells arranged in tubercle formation and degenerated areas which were undergoing calcification.

COMMENT

This patient was older than most of those who contract tuberculosis of the greater trochanter and his symptoms were of unusually short duration. From the history and the *x*-rays we suspected the presence of coccidiodal granuloma although pathological examination later proved the lesion to be tuberculous. The use of powdered sulfanilamide in the wound was undoubtedly of great value in the prevention of chronic sinus formation.

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OSTEOGENIC SARCOMA AS THE CONCOMITANT OF AN INDUSTRIAL ACCIDENT*

RODNEY F. ATSATT, M.D.
Chief of Orthopedic Division, Santa Barbara Clinic
SANTA BARBARA, CALIFORNIA

THE rather dry subject of bone tumors is best introduced by an interesting case history:

The patient, a genuine western cowboy with all the palaver and songs of a true Texan puncher, was twenty-nine years of age. He was born in Mucculla County, Texas. He began riding horses at the age of three years and had ridden them good and bad with the best of them. His right kidney had been jarred loose and there were many scars of accidents scattered over his body.

One of these accidents happened on April 12, 1939. At that time he was employed as cow hand by Ladder Ranch, Hillsboro, New Mexico. He was riding on the rim of a mountain when his horse stepped on ledge rock, tried to leap, his forefeet slipped and the horse and patient fell over backward. The patient rolled down the mountain side to lodge in oak brush with his right leg lying on a ledge of rock and with the fibular side down against the hard surface. The horse came down and rolled over the leg while in that position. The cowboy reported the accident to the foreman and general manager and was away from work three days. His leg did not bother him until March, 1940. *X*-rays were taken at that time and "a white cloud" was seen, surrounding the small bone. Gradually the leg became more painful and it grew in size. He returned to Texas in 1940, and on July 20, a four-inch section of the fibula was removed. Following this operation he was not uncomfortable until about November 1 when the leg began to ache constantly with occasional periods of sharp, boring pain. The pain and ache were worse at night. About December 10 the patient's leg was *x*-rayed in Prescott, Arizona, and it was found that the tumor had returned. Amputation was suggested by the attending surgeon. The patient notified his present employer who brought him to Santa Barbara from the ranch in Arizona.

On December 31, 1940, a midthigh amputation was done, turning a long anterior flap. The wound healed slowly. Inguinal nodes were subjected to a short course of *x*-ray therapy.

The roentgenograms previous to the amputation are depicted in Figure 1. *X*-rays of the chest were negative for metastatic tumor.

The pathological report is as follows: "The specimen is the right leg and distal third of the thigh. There is a well-healed scar 15 cm. in length on the lateral side of the lower leg. (Fig. 2.) Underneath the scar is a large, firm mass which on dissection is found to be intimately connected with the fibula, and the entire tumor and fibula are removed in one piece. (Fig. 3.) The tumor is oblong in shape, is infiltrating the muscles, especially the peronei. It is whitish in color, quite hard, and sections with difficulty. The internal appearance of the tumor is whitish-yellow. The consistency varies from very hard to very soft as one approaches the center."

The microscopic examination revealed the following: "Sections of tissue show the characteristic picture of osteogenic sarcoma. (Fig. 4.) The tissue is extremely cellular. The cells are large, though varying greatly in size and shape. The nuclei are prominent and many possess two or more nucleoli. Between the cells there is a hyaline, ground substance which in areas has the contour of bone spicules and in some areas shows remaining calcium deposits. The bone structure is of cancellous type without the presence of laminated markings or haversian canals. In areas there are scattered hemorrhages which have occurred from thin-walled vascular sinuses. Some of these sinuses show penetration by the tumor cells. (Fig. 5.) Innumerable atypical and unbalanced, bizarre mitotic figures are encountered. The picture is characteristic of an osteogenic sarcoma with a high degree of malignancy." (Wray Tomlinson, Pathologist.)

* Read before the Western Academy of Orthopedic Surgeons, November 14, 1941.

With this case history as an introduction we wish to review briefly the general subject of bone tumors.

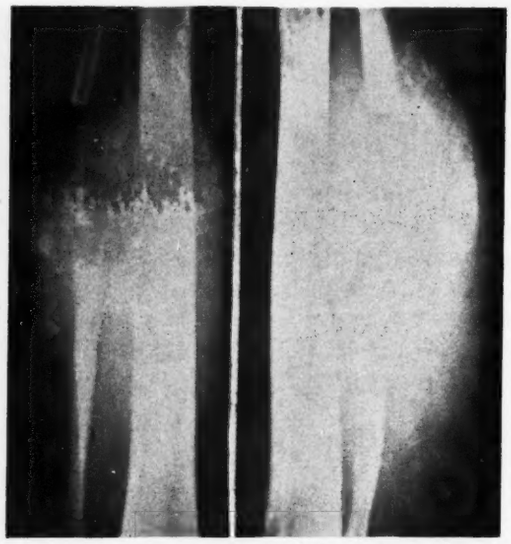

FIG. 1. Anteroposterior and lateral roentgenograms of tibia and fibula revealing operative defect in fibula and cloudy tumor mass.

The benign are of two general classes: (1) *osteomas* arising from the surface of long bones usually in the end zones, which may be compact or cancellous. These are usually multiple, frequently hereditary or traumatic and during their period of growth are often capped by a disc of cartilage. (2) *Chondromas* are cartilagenous tumors which occur ordinarily before the age of twenty and are located in the long bones of hands and feet. They are usually lobulated, encapsulated and may be cystic. It is believed that occasionally they may show sarcomatous changes.

The malignant tumors of bone are of four general classes: (1) *Osteogenic sarcoma*, (2) *Ewing's tumor*, (3) *myeloma* and (4) *giant cell tumor* (on occasion).

This discussion is restricted to the first class of the malignant tumors.

The term, osteogenic sarcoma, implies that it arises from cells whose function it is to form bone. The tumors are commonest in the second decade. They occur most frequently in the shafts of long bones and in the region of the knee joint.

Symptoms and Signs. Approximately five months go by in the average case before the aching pain sends the patient to the doctor. He then often recalls some type of trauma connected with the location of the pain. This aching discomfort rapidly becomes severe and constant and disability results. Since most of these lesions are in the neighborhood of the knee joint, stiffness, a limp, and crutches follow, but even with complete rest the pain does not disappear. Accompanying these symptoms are leucocytosis, lymphadenitis and fever with secondary anemia. This enlargement of the regional glands often occurs irrespective of the fact that transmission is via the blood stream.

Examination. Physical examination reveals a large mass near the flexed knee joint, rubbery in consistency. This feels larger than the *x*-rays indicate, but is only slightly tender to touch.

Roentgenology. Early *x*-rays show merely a translucent zone about the bone with some raising of the adjacent periosteum. Later *x*-rays show combined central and periosteal involvement with small marginal lip. The old shaft is visible but is permeated by the tumor, indicating the tumor's invasive character. As the result of the osteolytic and osteolastic activity, the sun ray appearance is often produced. This characteristic activity is reflected also in the widespread invasion into the soft tissues.

Gross Pathology. The tumor may implicate the medulla, shaft and periosteum, creating a fusiform swelling. On section the ray formation may be evident and the tumor is seen as having a variety of textures depending upon what elements of bone and bone-forming substances are involved. There may be pearly grey areas of cartilage with cysts and hemorrhage, dense stroma with closely packed tumor cells, bone spicules and masses of bone. As has been said, the gross appearance depends on the relative amount of the different bone or bone-forming substances.

Microscopic Pathology. As indicated in the description of gross pathology the microscopic detail of the tumor varies with

Fig. 2. Well healed operative scar on bulging lateral aspect of leg.

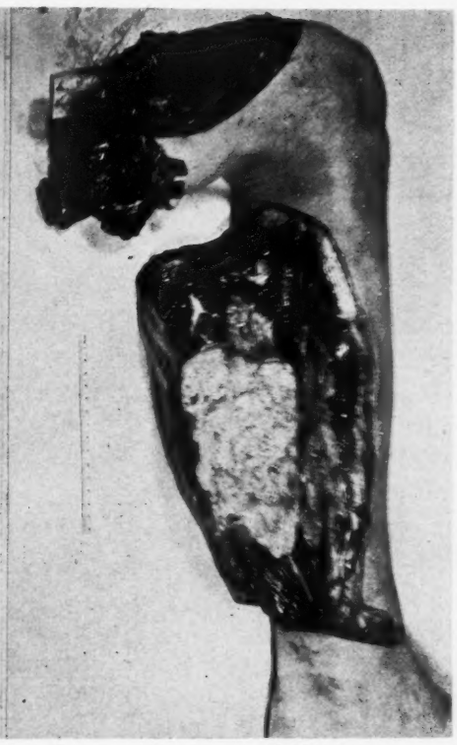

Fig. 3. Tumor split *in situ*.

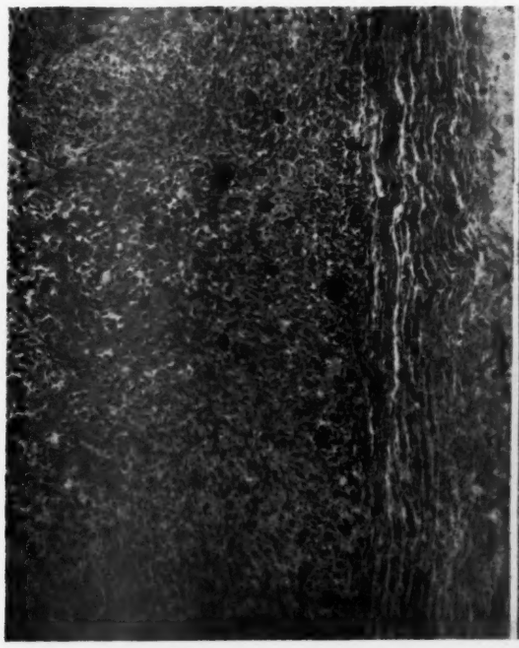

Fig. 4. Tumor (low power) invading muscle tissue.

Fig. 5. High power of tumor tissue.

its composition and covers the whole field of embryology of bone.

There are two main types of tissue: the cells and the stroma. Examining the cells there may be seen at first sight the pleomorphic osteoblasts for they dominate the picture with their hyperchromatic nucleii and mitotic figures. In another area in the same section the irregular cartilage cells may be prominent. Again the spindle-shaped tumor cells may fill the field, or here and there may be a few giant cells. Occasionally, osteoclasts are seen at work tearing down old bone trabeculae.

Turning our attention to the stroma or supportive framework, we may find hyaline or fibrocartilage, myxomatous, osteoid or finally osseous tissue. Every stage of bone growth may be represented in an osteogenic sarcoma, or one type may predominate.

Classification. Ewing's method of classification is based on the origin of the tumor, i.e., (1) periosteal, (2) medullary and subperiosteal, (3) sclerosing and (4) telangiectatic.

DISCUSSION

This stoical cowpuncher waited longer than normal after his accident before consulting a doctor. Instead of the average five months, eleven months had elapsed between the accident and the first consultation. *X*-rays at that time showed a "cloud" around the bone which was interpreted as callus about a healing fracture. It was not until the tumor reached sizeable proportions that it was taken seriously. Five months after the *x*-ray discovery of the tumor, a four-inch section of the fibula was removed. Six months later the tumor was again very large and painful and amputation was done at the midthigh level.

The record of events seems to start very definitely at the time when the patient's leg was crushed, fibular side down, against the rock. In the patient's mind at least there is a definite causal relationship therein. However, we can not say with certainty that this industrial injury was definitely the cause of the disability* but the sequence of events is so striking as to invoke the old rule of evidence, "Res ipsa loquitor."

SUMMARY

The patient, a western cowboy, was injured in an accident, while riding the range in April, 1939, in which his horse rolled over his leg lying fibular side down on a piece of rock.

In March, 1940, he began to have pain in the leg and an *x*-ray showed a "white cloud" surrounding the small bone which was interpreted as callus following a fracture.

In July, 1940, a four-inch section of the fibula was removed. In November, 1940, the leg began to be painful and in December an *x*-ray revealed the return of the tumor and the patient was brought to Santa Barbara. On December 31, a midthigh amputation was done.

Microscopically, the tumor was a large firm mass, oblong in shape and infiltrating the muscles. It was whitish in color and quite hard although the consistency in the central areas was very soft. The tissue showed the characteristics of osteogenic sarcoma. This tumor arises from cells whose function it is to form bone and, thus, is made up of all the elements of bone formation. In the usual case approximately five months pass between the time of injury and the time when aching pain sends the patient to the doctor.

* This tumor is registered as Accession 72666, Army Medical Museum.

TREATMENT OF DELAYED TONSILLECTOMY HEMORRHAGE

R. L. GORRELL, M.D.
CLARION, IOWA

THE practitioner who is confronted with late bleeding following tonsillectomy often wishes that the authorities who write so briefly and nonchalantly were at hand. The necrotic tissue cannot be grasped in the usual manner with a hemostat; sutures tend to cut through; local applications are of temporary effectiveness only; injections of the various sera are ineffective. Bleeding usually occurs in patients with infected tissue, so that the more manipulation is carried out, the more chance there is of spreading infection both locally and in the blood stream.

CASE REPORTS

CASE I. John R., age ten, had had a tonsillectomy some ten days previously by another physician. No complications at the time or later was noted. On the ninth postoperative day, bleeding suddenly appeared and without obvious cause. It ceased spontaneously only to reappear in a few hours.

This process was repeated several times, before help could reach them through the heavy snows. When the youngster was lifted up into the car, blood poured from his mouth in a stream and he became syncopic. A sponge holder containing a large square of gauze was forced up into the tonsillar fossa and held there until the hospital was reached.

The hemorrhage had stopped by the time the boy was carried into the hospital. No local treatment was carried out, because the boy was in shock. A citrated transfusion was begun at once and 500 cc. were given.

He did not bleed one drop following the transfusion and was dismissed in twenty-four hours in good condition. No definite bleeding point was seen in the throat; no blood dyscrasia was discovered at the time, or since, and he has remained in good health since 1937.

CASE II. Mrs. A., age twenty-nine, suffered a streptococcic pharyngitis, followed by otitis media. Her tonsils remained persistently infected and I removed them one month later. The left tonsil, on the same side as the affected ear, was spongy, contained much purulent material and tended to ooze a drop occasionally afterward. She went home the next morning, however, with a dry throat. She was given calcium gluconate and lactate powder, vitamin K and bile salts.

On the second postoperative day, she came to the office because of slight oozing from the left tonsillar fossa. The right fossa was clean; the left was markedly reddened and edematous and there was a little bleeding from the posterior surface of the anterior pillar which stopped when a solution of ferric chloride, glycerin and tincture iodine, equal parts, was applied.

On the third postoperative night, she awoke with steady bleeding from the fossa. Powdered cocaine was applied and nupercaine solution for local anesthesia. Procaine solution could not be injected because the soggy tissue bled on being touched with the needle. Suturing and clamping were ineffective; compression with gauze soaked in adrenalin and bismuth subgallate checked the bleeding temporarily.

Five hundred cc. of the husband's blood was given to her by the citrate method. Within twenty minutes, the bleeding, which had been steady for four hours, stopped and did not recur.

She left the hospital in twenty-four hours and has been in perfect health since that time. It might be of interest to mention that complete blood studies both before and after operation disclosed nothing abnormal; urinalysis was negative.

CASE III. Mrs. H., age forty-seven, was operated upon by another physician in 1936. She had a fever of 100°F. the next day (a not unusual occurrence) but was dismissed in apparent good condition.

Six days later, she returned because of swelling of the side of the neck and soreness in the tonsillar region on that side. No bleeding occurred at this time. The lateral aspect of the

neck was obviously enlarged and moderate tenderness was noted over the rounded swelling. The tonsillar fossa was moderately swollen but contained only the usual membrane. Under rest in bed, hot packs and analgesics, the pain decreased and the swelling diminished in size during the next three days. She was dismissed, feeling fairly well.

On her return, two weeks following the tonsillectomy, the swelling was larger than ever, she was having marked pain in the area and a fever of 102°F. was present. The swelling was definitely indurated at this time, and the attending surgeon made a diagnosis of post-tonsillectomy cervical abscess. While the instruments were being sterilized, the surgeon went off to see other patients.

Sudden spontaneous hemorrhage occurred from the tonsillar fossa, which did not at first appear serious and the surgeon applied gauze packs and local applications which slowed down the bleeding. The structures were so edematous and indurated that suturing and clamping were not feasible. The carotid artery could not be ligated because of the indurated mass, the size of a large grapefruit, overlying it. The patient went into shock and died before a transfusion could be given.

DISCUSSION

To any one who has seen bleeding patients stop bleeding and recover quickly after a transfusion, it seems obvious that replacement of blood volume and proteins by a transfusion is the simplest and best treatment. It is unfortunate that the classification of tonsillectomy into an otolaryngologic procedure tended to separate it from other surgical undertakings and into the hands of men who had little or no experience in the technic of or benefits to be derived from transfusion. Now that serum transfusions can be given so easily, there will no doubt be an increase in the number of transfusions given.

A review of the literature available shows what procedures are recommended by various authors:

Christopher[1] advises rest, ice collar, morphine, astringents (ferric chloride, compound alum powder) or coagulants as thromboplastin or fibrogen, direct pressure with gauze or forceps, ligation of bleeding point, and ligation of carotid artery.

Bailey[2] recommends packing into the wound a strip of gauze, which may be moistened with viper venom solution, turpentine or 50 per cent dextrose solution, making sure that it is packed *snugly* into the fossa; it is removed in fifteen minutes and the pulse counted every one-half hour to give warning of recurrence. If ineffective, ether anesthesia should be administered and the cavity packed again with moist gauze. This should be allowed to remain for five minutes. Then ligation should be done, if the bleeding point is found, or a small gauze swab should be placed in the cavity and the pillars sutured over it, taking care to pick up the muscle with each stitch. If bleeding is severe, a transfusion should be given (why wait until it is severe?) and the bleeding stopped by packing or by pressure of gauze squares held in sponge holding forceps against the ascending ramus of the jaw. Ligation of the external carotid artery should follow and the surgeon should make sure that the ascending pharyngeal branch, which comes off near the origin and on the inner surface has been included. Rarely does the opposite external carotid artery require ligation, as it affords the only free anastomosis.

Lederer[3] states that before operating the surgeon should inspect the pharynx for anomalous arteries and palpate the region of the tonsil to detect any unusual pulsation. He should apply pressure with a gauze sponge held over the bleeding tissues; apply adrenalin or saturated solution of tannic and gallic acid; clamp the bleeding point and follow this by suture-ligature. In case of severe hemorrhage apply digital pressure on the carotid artery at the point where it is felt pulsating just below the larynx (sixth cervical vertebra). Pressure should control hemorrhage sufficiently long to permit ligation of the external carotid artery. Blood should be given intramuscularly or by transfusion.

Hall[4] suggests the removal of the clot, which procedure often stops hemorrhage;

the application of pressure on the fossa with cotton or gauze balls moistened with hydrogen peroxide; suture-ligature of bleeding point; clamp-forceps which press on fossa and behind the angle of the jaw. "In late hemorrhage, there is a bleeding point in the middle of a bed of granulation tissue which is practically impossible to catch with forceps. Pressure is the best method; deep under-stitching can be tried."

Coakley[5] states that each bleeding point should be ligated with fine silk at the time of operation; recurring hemorrhage is treated by gauze pressure and ligation.

Turner[6] recommends hydrogen peroxide sponges; clamping and ligature of bleeding vessel; the application of pressure by means of a sponge in a sponge-holder, which is held firmly in the bleeding fossa, directed from the opposite angle of the mouth.

Morrison[7] applies pressure with a gauze sponge moistened with adrenalin, injects local anesthesia, the edema of which often stops oozing, and clamps or clamps and sutures.

Coolidge[8] applies direct pressure with gauze sponge. Three deep sutures are passed from behind forward, through the posterior pillar, constrictor muscle and anterior pillar, and tied, thus obliterating the space made by removal of the tonsil.

Thorek[9] recommends that the surgeon look for marked pulsation, which indicates the close proximity of a large vessel, before operating, and that he know the anatomy of the external carotid artery, as ligation of the internal or common carotid arteries usually fail.

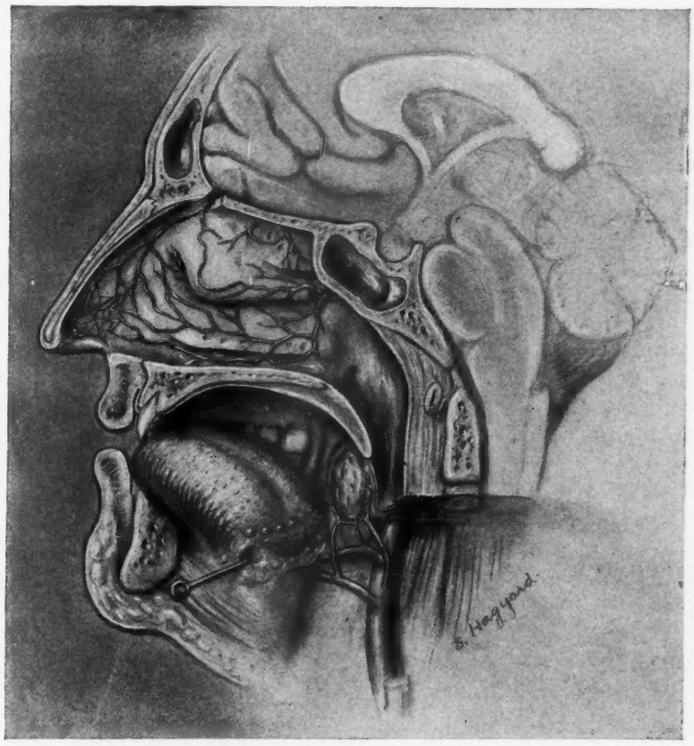

Fig. 1. The blood supply of the tonsil.*

* Parke-Davis and Company kindly granted permission for the use of the cut from "Therapeutic Notes."

CONCLUSIONS

1. In case of persistent or marked bleeding, it is safest and most effective to give a blood transfusion. One fatal case is reported in which this precaution was not taken.

2. It is dangerous to stop bleeding at the time of operation with adrenalin applied locally, as the hemostasis may be only temporary.

3. Hemorrhage is often stopped by a blood transfusion.

4. Hydrogen peroxide applied locally or by gargling will often stop oozing of blood.

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Enlarged nodes in the postauricular and occipital areas and in the posterior triangle are, notably in children, strongly suggestive of pediculosis capitis, and call for a search for pediculi or "nits."

THE TREATMENT OF HEPATIC CIRRHOSIS BY THE COMBINED USE OF THE TALMA OPERATION AND INSULIN

CASE REPORT

J. M. BODENHEIMER, M.D.
Visiting Surgeon, T. E. Schumpert Memorial Sanitarium
SHREVEPORT, LOUISIANA

A CAREFUL search of the records of the Shreveport Charity Hospital from 1924 to 1940 fails to show a single case of cirrhosis of the liver discharged cured. More than 90 per cent of the patients died in the hospital, while the remaining 10 per cent were probably sent home to die. Bettman in Forsheimer's "System of Medicine" is certain that a well established cirrhosis of the liver cannot be cured anatomically. As for ascites, it is a grave symptom. "Its occurrence," according to Rolleston, "has always spelled the doom of the patient." The literature up to 1928 gave two to five months as the average life after ascites appeared. Today writers are more liberal and concede a span up to two years, granted the patient has been under proper care.

While there have been reports of spontaneous cures of ascites, nevertheless the rarity of the incidents and the great suffering experienced from repeated refilling of the abdomen with fluid and the necessarily repeated tappings, surely justify the attempts toward relief by any methods short of cruel or painful procedures. Omentoplexy described by Talma forty-two years ago and modified by Morrison, Babler and others, for various reasons has fallen into disuse time and again, only to be resurrected by those who have taken the trouble to study its limitations and advantages.

"The discovery of insulin, the vagus substance regulating the glycogen synthesis in the liver cells" has given us a second great and good weapon in our fight against hepatic cirrhosis and ascites of the portal variety.

I wish to report an arrested case of cirrhosis of the liver receiving the benefits of both omentoplexy and insulin injections:

CASE REPORT

M. K., a white male, age forty-one years, was admitted to the Schumpert Sanitarium August 5, 1939, with delirium tremens. He had been a constant and continuous gin drinker for a number of years, which culminated in the condition for which he entered the sanitarium. He was restrained with considerable difficulty and after the usual sedative treatment his mental condition was relieved. Examination revealed apparently normal heart and lungs. The blood pressure was 130/90, pulse 90, respiration 20, temperature 98°F. The liver was enlarged, extending from the ninth rib to below the level of the umbilicus. Hemorrhoids were large and the anus was everted. The abdomen was filled with fluid. The surface veins of the abdomen were not prominent. There was no edema of the extremities and no puffiness about the eyes. There were no signs of jaundice, the sclera being clear or very slightly yellow-tinged. A low fluid intake, high carbohydrate-protein and low fat diet was instituted. Salyrgan and ammonium nitrate were administered over a period of five days with negative results. He was tapped August 10, 1939, and a gallon of fluid was obtained. Thereafter he was tapped every five to seven days, increasing amounts of fluid being obtained each time.

On September 1, 1939, the Babler modification of the Talma operation was performed under local anesthesia. The abdomen was opened in the mediam line between the ensiform cartilage and the umbilicus. A large quantity of

clear light fluid was evacuated. The liver was visualized and was observed to be of the hobnail variety. The omentum was very large, thick and broad. There were no adhesions encountered. The omentum was brought through an opening in the peritoneum, spread out, and attached by means of several plain catgut sutures to the undersurface of the muscles. The sheath was closed with chromic catgut and the skin with interrupted silkworm gut. There was no shock. The patient was absent from his room just thirty minutes. The skin sutures were removed on the twelfth day. There was no infection, however, the patient's abdomen continued to fill rapidly. It was necessary to tap him every five to seven days when as much as two gallons of fluid were usually obtained. On December 28, 1939, he was tapped for the last time. At several tappings previous to this date it was noticed that the amount of fluid obtained was being gradually diminished. From then on the fluid was controlled with salyrgan and theophylline intravenously and ammonium nitrate by mouth. On December 14, at the suggestion of Dr. Lloyd, 5 units of insulin three times a day was started. The results were highly satisfactory. The patient's appetite improved and the ascites gradually disappeared after three weeks use of insulin so that by February salyrgan was no longer necessary. He was discharged from the hospital February 28, 1940. At the present time he is back at work as a salesman in a furniture store. He still adheres to his diet and the insulin and refrains from gin. There has been no recurrence of the ascites and no salyrgan, theophylline or ammonium chloride have been used since his discharge from the sanitarium. It is not uncommon for the fluid to cease to accumulate after repeated tappings, presumably because of the establishment of venous anastomosis at the site of the puncture.

Therefore, I do not presume to say that the operation could be the only reason for the relief of the ascites. According to Warbasse-Smythe, improvement should be secured in 90 per cent of patients operated upon if the operation is done before the health of the patient is seriously impaired. The operation usually fails in cases of chronic congestion of the liver. In Laennec's or portal cirrhosis which is characterized by an absence of jaundice and pathologically by undisturbed liver cells and large biliary ducts, the operation is indicated. According to A. Blod, 40 per cent of cirrhosis of the liver operated upon by this method, are relieved of the ascites. The reason for the failure in the other 60 per cent of the operations is that the operation has been improperly used. An absence of jaundice and adhesions, and a large omentum insure the success of the operation.

The original operation first described by Talma* was best performed under a general anesthetic. The upper surface of the liver was rubbed with gauze for the purpose of irritating its peritoneal covering and causing it to become adherent to the diaphragm. The peritoneum in the neighborhood of the surgical incision was rubbed and the omentum sewed to the irritated surface. Bickham advocated the use of a brush generally used in preparing the hands for operation for the irritation procedure, and also irritating the serous surface of the spleen as well as the liver.

E. A. Babler and others have modified the operation which can be done under local anesthesia, the operation which I have described in the report of my case.

The adhesions which form as a result of the operation cause anastomosis between the veins of the mesenteric system and those of the anterior abdominal wall; and blood from the veins of the abdomen is carried to the vena cava without passing through the portal veins and liver. This process takes from four to six months before results are noted. Subcutaneous drainage for ascites has been attempted by many methods; silk thread, glass tubes, silver wire tubes of fascia, skin, serous membrane have all been used. Anastomosis of the saphenous vein with the peritoneum was performed by Rontte. According to Warbasse, while the reports from a few cases show good results, the operation probably has no permanent value. P. Rosenstein has described a valve-like opening in the urinary bladder. Anastomosis between the vena cava and the portal vein, between

* *Berlin klin. Wchnschr.*, September 19, 1898.

the superior mesenteric vena cava and between the superior mesenteric and the ovarian veins have also been suggested. But the Talma operation and its modifications appear the most practical surgical procedure for the treatment of ascites due to hepatic cirrhosis. Detiverlier says that the "Talma operation has been more or less successful in certain cases in encouraging anastomotic circulation."

E. L. King who has collected 227 cases reports the following:

	No.	Per Cent
Deaths	75	33
Failures	34	15
Improvements	29	13
Cured	84	37.3

Walter Hughson reports twenty-eight cases as follows:

Peritoneum and liver scrubbed	9
Liver painted with iodine	1
Omentoplexy	12
Cholecystomy	2
Splenectomy	1
Simple laporatomy	1
Reaccumulation of fluid	17
Known to be dead	16
Survived average	22 days

Arthur Tempsky reports twenty-five cases of which thirteen were hypertrophied, eight atrophic cirrhosis and one cardiac cirrhosis showed marked improvement for a long time. Three cases lived twelve, five and four years, respectively. The one that lived twelve years was tapped after two years.

Strobel who reports eight cases had two cures, both hypertrophic cirrhosis. Simon who has collected 224 cases is of the opinion that hypertrophic cirrhosis offers the more favorable prospects for satisfactory results. Bickham, quoting Moynihan, states that the most favorable cases for operation are those in which the liver is enlarged rather than atrophied. Munkowski is also of the opinion that in hypertrophic cirrhosis the results are much better than in the atrophic variety. Practically all surgeons who have had experience with this operation are in agreement that the operation should be performed early and not as a last resort. Talma has suggested that a patient should not even be tapped before the operation is performed. In the Hanot (primary) and the Chacot (obstructive) cirrhosis, the operation should never be attempted. Diabetes, heart disease, tuberculosis and nephritis and contraindications for the operation. In recent years the operation has fallen into disuse probably because the indications and contraindications were not so well understood. Talma only advised the operation when the liver cells were not impaired greatly. Icterus, urobilinuria, acholia, hypocholia of the feces, xanthoma and pigmentation of the skin were signs according to Talma that precluded success for the operation. Simon who, as I have stated, previously collected 212 cases reached the same conclusions as Talma had reached, that is, that the operation should be performed at the first signs of ascites and then only when the cirrhosis is of the portal type.

The use of insulin in the treatment of cirrhosis of the liver is not new. From time to time there have appeared reports of the successful use of insulin in this disease. McCabe and Hart reported five cases in 1933. Walker and Wood reported a most unusual result with insulin in 1935, while F. Hart and J. R. Lisa have recorded an arrested case verified by autopsy, the patient having died of an acute attack of pneumonia unrelated to the chronic condition with which he was afflicted.

I have been unable to find a single instance recorded in which the patient has had the benefit of both the Talma operation and the routine use of insulin and high protein-carbohydrate diet. I am not unmindful of the fact that the successful issue in one case is by no means conclusive proof of the efficacy of treatment. Indeed, scattered throughout medical literature one finds many reports of cases of ascites arrested as the result of various procedures, but the happy results reported from time

to time as the result of the use of either procedure used in this particular case, certainly places their combination upon a sound and practical foundation. It is hoped that others will try out this method for the treatment of a condition which for some time has been considered hopeless by many students of the problem.

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Occasionally, signs of acute hepatic insufficiency, may occur in the absence of obvious signs of portal obstruction. In such instances the liver failure is often precipitated by some toxic agent such as morphine, alcohol, or a coincidental infection.

TOTAL GASTRECTOMY

REPORT OF TWO CASES

LON GROVE, M.D. AND E. A. RASMUSSEN, M.D.
Associate Professor of Surgery, Emory University Medical School
Surgical Resident, Emory University Hospital
ATLANTA, GEORGIA

WHILE total gastrectomy is still not a common procedure, during recent years there has been an increasing number of successful cases reported, and there are probably others which have not appeared in the literature. It has frequently been urged that this be done, hence we are reporting two additional cases.

The scirrhus form of carcinoma,[3] generally spoken of as the leather bottle stomach is generally accepted as the ideal lesion necessitating total extirpation. This is because of its slow growth, and the relatively rare extragastric metastasis, until the last stages of the disease. It was this type of lesion that necessitated total gastrectomy in the two cases being reported. In each case the growth involved the entire stomach, except for a small portion at the cardia, and in neither case was there gross evidence of involvement of the surrounding tissues or lymph-nodes. Upon entering the hospital neither patient showed evidence of marked anemia or malnutrition and both were considered good operative risks.

Case I is now fourteen months postoperative and, during this time, the patient has eaten well, has had no marked digestive difficulty or epigastric distress, and there has been no diarrhea, except on one occasion; and she has not shown marked macroscopic anemia. She has recently begun to lose weight and we believe shows evidence of recurrence.

Case II is now three months postoperative. She is taking four small meals daily without discomfort or diarrhea, has shown no anemia to date and is gaining weight.

The technic employed is a modification of those described by Lahey, Graham and others. The night before, and the morning of operation, the stomach is thoroughly lavaged with .5 per cent dilute hydrochloric acid, and the Levine tube is left in the stomach.

In both cases the operation was performed under nitrous oxide-ether anesthesia. A high midline incision, from the ensiform to a point approximately one-half inch below the umbilicus, was found to be satisfactory, and it was not necessary to carry out cartilage or rib resection or to enlarge the incision in any manner. After the stomach had been completely mobilized, by ligating the gastrocolic and gastrohepatic attachments, the duodenum was cut across between clamps, with cautery, and the end inverted in the usual manner. At this time the Levine tube is withdrawn to such a position that the tip lies in the distal end of the esophagus and continuous suction is applied so that any mucus in the esophagus is aspirated while the anastomosis is being performed. Using the stomach for traction, the esophagus is freed from the diaphragm, by turning up an anterior and posterior flap of the serous coat of the diaphragm, and by so doing, cutting the right and left vagus nerves, freeing the esophagus which can be drawn down for a distance ample for resection and anastomosis. A long jejunal loop is next brought through a rent in the transverse mesocolon and sutured to the diaphragm with interrupted sutures of silk, as the first layer of the posterior suture line. We placed the loop postcolic because we believe that there is less drag than when it is placed anticolic, which results in less tension on the anastomosis and, therefore, causes less pull on the anastomosis. The esophagus is now cut across and an esophagojejunos-

tomy is performed using No. 000 chromic catgut as suture. The flaps of the diaphragmatic peritoneum are now turned down and sutured to the jejunum below the line of anastomosis. This point in technic has been emphasized by Lahey,[1] as serving two purposes: first, to overlap the line of anastomosis thereby reinforcing it; second, to act as stay sutures relieving the pull or strain on the anastomosis; an entero-enterostomy is now performed between the limbs of the jejunal loop. This has been done for two reasons: first, to encourage rapid emptying of the proximal loop, in order to lessen the weight on the anastomosis; second, to prevent regurgitation of bile into the esophagus.

The Levine tube remains in the esophagus for the first five postoperative days, and is aspirated at frequent intervals, and nothing is allowed by mouth or through the tube, nutrition being maintained entirely by the use of intravenous fluids, with the addition of concentrated vitamins. Jejunostomy, as advocated by some, was not employed in either case.

On the morning of the sixth postoperative day, the tube is withdrawn, and water, milk and lime water are given so that the patient receives a small amount each hour. These are continued until the tenth day, when fruit juices, cream of wheat, strained oatmeal and a soft boiled egg, in small amounts, are added to the diet. The patient, by this time, is receiving small feedings every two hours. By the fourteenth day, the equivalent to a soft diet is begun. This is given as small feedings five times daily. Before dismissal from the hospital, the patient is taking four small meals daily without discomfort, along with vitamin therapy and desiccated pig's stomach. The postoperative course in both cases was surprisingly smooth and without complications.

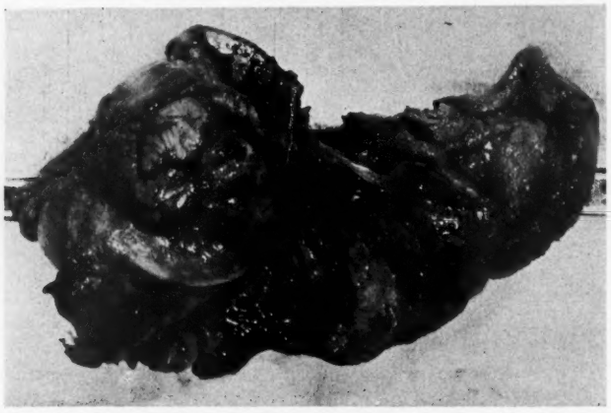


Fig. 1. Case 1. Illustration of stomach showing diffuse scirrhus carcinoma.

CASE REPORTS

Case 1. A woman, age forty, was seen at the Winship Clinic September 10, 1940, at which time she complained of epigastric discomfort for a duration of one year. The dull epigastric pain usually followed meals and the swallowing of only very small amounts of liquid resulted in a sensation of extreme gastric fullness. She had noticed no tarry stools. She had lost approximately thirty pounds weight during six months prior to admission. Family and past history were negative.

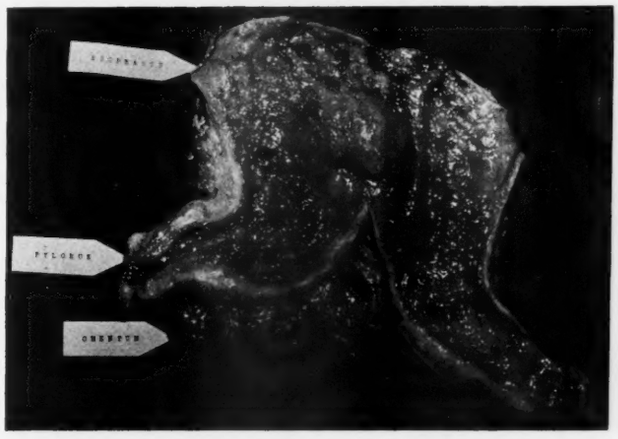
Laboratory studies revealed erythrocytes, 4,000,000, hemaglobin 65 per cent, leukocytes 4,800, negative urinalysis and negative blood Kahn. Gastric analysis revealed fifteen degrees total acidity, no free hydrochloric, one plus lactic acid and one plus blood. *X*-ray diagnosis of scirrhus carcinoma of the stomach was made.

Total gastrectomy was performed September 18, 1940. The pathology department reported infiltrating mucoid carcinoma of the stomach.

On September 23, 1940, erythrocytes numbered 3,200,000, hemaglobin was 55 per cent, and leukocytes numbered 4,600. October 2,

1940, blood analysis revealed 3,500,000 erythrocytes and 58 per cent hemaglobin. December 14, 1940, erythrocytes were 3,700,000 and hemaglobin 66 per cent. January 17, 1941, erythrocytes numbered 4,400,000 and hemaglobin 82 per cent.

A



B

FIG. 2. Case II. A and B, illustrations of stomach and omentum showing diffuse scirrhus carcinoma.

This patient has now been living more than one year and for most of this duration has been comfortable. She had one attack of diarrhea with cramping two months after leaving the hospital, which lasted for four days. She has now lost considerable weight, has developed some ascites and in all probability has a recurrence.

CASE II. A woman, age forty-seven, was seen at the Winship Clinic July 29, 1941, at which time she complained of a dull ache in her epigastrium accompanied by nausea which seemed to come on more commonly when her stomach was empty. These symptoms had persisted for four months prior to the time at which she was seen. Food seemed to alleviate the dull epigastric ache and nausea. She vomited at irregular intervals but gave no history of hematemesis. There had been no tarry stools. She had had considerable belching, her appetite had been poor and she had lost eighteen pounds weight during three months prior to admission. Family and past history were negative.

Fluoroscopic and serial film studies of the stomach revealed a persistent filling defect involving the upper two-thirds of the stomach and lower esophagus. The appearance was that of a scirrhus carcinoma of a linitis plastica type.

Due to the extensive type of lesion which apparently involved the esophagus and to the fact that the growth might have been a lymphosarcoma, she was given deep *x*-ray therapy.

She returned to the clinic August 25, 1941, at which time *x*-ray studies revealed no change in the appearance of the lesion so she was

admitted to the surgical service for esophagogastroscopy and possible total gastrectomy. Esophagoscopy, August 25, 1941, by Dr. Wright, revealed no esophageal lesion and a biopsy from the gastric fundus just beyond the cardia demonstrated chronic inflammation of the stomach wall.

The laboratory reported erythrocytes 4,200,000, hemaglobin 75 per cent, leukocytes 7,300, negative urinalysis and negative blood Kahn.

Total gastrectomy was successfully performed August 30, 1941. The pathology department reported scirrhus carcinoma of the stomach with diffuse wide spread infiltration of the gastric wall. On September 8, 1941, erythrocytes numbered 4,480,000, and hemaglobin was 80 per cent. September 24, 1941, erythrocytes were 4,600,000 and hemaglobin 92 per cent. To the present time she has had no epigastric distress, feels much better then formerly, her general condition is satisfactory and she is gaining weight slowly.*

* This patient returned to the clinic on November 19, 1941, at which time she appeared well and had no complaints. The blood count showed 3,900,000 red cells and 78 per cent hemaglobin. She was taking a soft diet well without discomfort. *X*-ray showed the anastomosis functioning well and a chest plate was negative for metastasis.

SUMMARY

Two cases have been presented in which total gastrectomy was successfully performed. A diagnosis of linitis plastic type of schirrhus carcinoma of the stomach was made in each instance and in neither case was there gross evidence of extragastric metastasis although gastric symptoms had persisted, for one year and four months, respectively.

Both patients recovered from the operation with surprising ease and within two weeks were taking soft foods without discomfort.

We know that these cases are more comfortable following total removal of the stomach and that their general condition improves, therefore, it is not beyond hope that some may be cured by such a procedure.

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DELAYED SPLENIC RUPTURE

REPORT OF A CASE

HENRY N. HARKINS, M.D.
Associate Surgeon, Henry Ford Hospital
DETROIT, MICHIGAN

THE importance of traumatic injuries of the abdomen is especially to be emphasized in these days of national emergency. Any data pertaining to and clarifying the nature of such emergencies are now of vital consequence. Of all serious subcutaneous intra-abdominal traumatic injuries, splenic rupture heads the list. The percentage of such injuries that involves the spleen has been variously stated by different authors as shown in Table I. Rupture of the spleen, at least in civilian life, is about twice as common from closed as from open abdominal injuries as shown in Table II, but this preponderance of the former is less evident in war injuries.

TABLE I
RELATIVE FREQUENCY OF TRAUMATIC RUPTURE OF THE SPLEEN IN A SERIES OF SUBCUTANEOUS ABDOMINAL INJURIES

Author	Year	Percentage of Splenic Ruptures
Mazel	1932	30
Bronaugh	1935	33
Wright and Prigot	1939	48
Average	....	37

TABLE II
COMPARISON OF MORTALITY OF OPEN AND CLOSED INJURIES TO THE SPLEEN
(After Maes and Rives, 1941)

Type of Case	No. of Cases	Deaths	Mortality, Per Cent
1. Open (gun shot wounds).	11	10	91
2. Closed, total	26	9	35
a. Auto accidents	11	6	55
b. Falls	11	2	18
c. Miscellaneous*	4	1	25

* Run over by wagon, struck by bicycle, fist fight, and struck by iron pipe, each one case. The first of these listed died while the other three recovered.

The occurrence of delayed splenic rupture is important and should be recognized by all those treating traumatic patients. This syndrome has been neglected in the literature and is undoubtedly more common than is realized. McIndoe (1932) collected forty-six cases, while Steenrod (1940) added eight additional cases, bringing the total to fifty-four. Wright and Prigot (1939) reported two cases while Fey and Turow (1941) reported one. This makes a grand total of fifty-eight cases of delayed splenic rupture, including our own case. The following case report is made to stimulate interest in this syndrome:

CASE REPORT

O. M., a white male, aged forty-eight, employed as a millwright foreman, previously in good health, was in an automobile accident on November 18, 1940. He was unconscious for a few minutes and when he regained consciousness complained of a headache, soreness in the left knee and a "wrench" of the left side, in the region of the lower ribs in the midaxillary line. Of the three complaints, the headache and pain in the left knee were the most severe. However, because he felt tired and "washed out," he remained in bed most of the time during the ensuing four days.

At about 11 P.M. on November 22, 1940, the patient became very pale, his pulse became very weak and when a physician who was called examined him his blood pressure gradually dropped during the three-hour interval until he was brought to the Henry Ford Hospital in an ambulance.

On admission at 2 A.M. on November 23, 1940, the patient appeared quite pale. The blood pressure was 80/50, the pulse 120, and

the red count was moderately reduced. The urine was normal. Physical examination was essentially negative except for the abdomen and the generalized pallor, arterial hypotension and tachycardia. The abdomen was moderately distended and tense with generalized rigidity and tenderness, most marked in the left upper quadrant. A diagnosis of possible ruptured spleen was made and operation performed at 3 A.M., one hour after admission, under ethylene-ether anesthesia.

Operation. A left paramedian incision was made from near the costal margin to the level of the umbilicus. On opening the peritoneal cavity a large amount of free blood was found. To expose the region of the spleen more easily, a left lateral transverse projection of the longitudinal incision was made for a distance of 11 cm. from the lower end of the latter. On freeing loose fibrinous adhesions around the spleen, still more blood welled up and it could not be definitely ascertained whether this represented fresh bleeding or merely release of a partially encapsulated hematoma. At any rate, there was a marked flow of blood up into the wound estimated at 1,200 to 1,500 cc. Because of the urgency of the situation a plasma transfusion was begun. The spleen was felt to be intact, except for a rent in the capsule about one or two inches long on its convex surface, and already partially freed from its diaphragmatic attachments. It was further rapidly mobilized by incision of the posterior layer of the lienorenal ligament and the pedicle constricted by wrapping a Mikulicz pad around it, the left hand maintaining compression. This method of stopping bleeding from the ruptured surface of the spleen was quite effective, but had the disadvantage of leaving little room to ligate the pedicle. Finally, the main artery and vein were separately ligated with No. 0 chromic catgut and the spleen was removed. A few small bleeding points along the gastrolienal ligament and its reflection onto the diaphragm were ligated. No further exploration of the abdomen was made except to note that the liver, stomach, duodenum, and gallbladder all appeared grossly normal. The gallbladder was not felt, however.

The abdomen was closed without drainage or retention sutures. A continuous suture of No. 0 chromic catgut was used for the peritoneum and posterior sheath of the rectus, while interrupted far-and-near mattress sutures of the same material were used for the anterior sheath, and the skin was closed with interrupted silk sutures.

Postoperative Course. At the end of the operation, after administration of 200 cc. plasma, the blood pressure was 100/65 and the pulse 100. Immediately on return to his room the patient received 300 cc. more plasma and the blood pressure gradually rose to 125/75. He developed an atelectasis which was treated by bronchoscopy and he left the hospital three weeks after admission. Of interest is the fact that two months later he was admitted to the hospital (February 6, 1941 to March 4, 1941) with what apparently was catarrhal jaundice. At no time was there evidence of portal thrombosis.

Pathologic Examination. The spleen measured 18 by 8.5 by 4 cm. and weighed 285 Gm. The capsule was smooth except for some adhesions over the convexity and a point of rupture 2.5 cm. in length on the convex margin opposite the notch. Considerable clotted blood was attached to the surface and a hematoma 3.5 cm. in diameter was present under the capsule at the site of rupture. On section this rupture extended into the substance of the spleen for a distance of 4 cm. and the tract had a diameter of 1.5 cm. The remaining splenic tissue showed a normal architecture with normal follicles and no degenerative change. Microscopically, no inflammatory reaction was seen and the rupture and hematoma were demonstrated.

Postoperative Treatment. The occurrence of portal thrombosis is a frequent complication according to Murray (1941) while Maes and Rives (1941) stated that "the common fear of portal thrombosis seems to be unfounded." This patient received heparin intravenously during his postoperative course and there was no evidence during the hospital stay of any portal thrombosis. The attack of catarrhal jaundice occurring two months after discharge may or may not have been a part of such a syndrome. No evidence of ascites was present at any time after operation.

COMMENT

Diagnosis. Maes and Rives (1941) have aptly said that "there is no pathognomonic picture of rupture of the spleen." However, when it is remembered that this is the most common, serious, subcutaneous abdominal

injury, it must be thought of whenever evidences of shock, hemorrhage and peritoneal irritation follow severe injury. In instances of ruptured viscus, the elements of shock and hemorrhage, even though present, are not so dominant while the signs of peritoneal irritation are more prominent. Wright and Prigot (1939) advised paracentesis in cases of splenic rupture, obtaining positive evidences of intraperitoneal bleeding in thirteen of fifteen cases. I would tend to agree with Maes and Rives (1941) that in cases of doubt an exploratory incision is preferable to blind paracentesis. In one such case of mine even the exploratory incision did not at first reveal blood, the latter only appearing when the hand was placed in the peritoneal cavity. When this was done, a large volume of blood welled up into the wound.

Table III

FREQUENCY OF DELAYED SPLENIC RUPTURE ACCORDING TO LATENT PERIOD IN FIFTY CASES*

Latent Period in Days	No. of Cases
2 to 6	24 (48%)
7 to 11	14 (28%)
12 to 16	5
17 to 21	4
22 to 26	1
26 to 30	1
More than 30 days	1
Total	50

* This table includes forty-nine cases reported in the iterature, as well as the author's case.

Time of Rupture. As shown in Table III, delayed rupture may occur more than thirty days after the original injury. Most of the cases happen, however, during the first eleven days, 78 per cent of instances occurring during this interval and two-thirds of these occur during the first six days.

Treatment. The only treatment is prompt operation with adequate shock therapy. In a series of forty-five reported cases with operation, the mortality was 25 per cent. It is probable that the use of more modern methods including adequate doses of whole blood or plasma would markedly reduce this figure.

SUMMARY

A case is reported of delayed splenic rupture occurring four days after the original trauma of an automobile accident. A study of fifty-eight such cases indicates that approximately 50 per cent occur during the first week after injury and about 25 per cent additional during the first half of the second week. Prompt operation with splenectomy supported by adequate blood or plasma transfusions is the procedure of choice. The importance of this traumatic injury in wartime is emphasized.

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CHONDROBLASTIC MENINGIOMAS*

JOSEPH H. SIRIS, M.D.
Assistant Neurological Surgeon,
Queens General Hospital

AND

ALFRED ANGRIST, M.D.
Pathologist, Queens General Hospital

JAMAICA, NEW YORK

ONE of the most favorable, but perhaps the rarest of intracranial new growths is the intradural chondroma, which because of its location has been accepted by Cushing and Eisenhardt as one of the meningioma group. An idea of the incidence of this tumor is afforded by the fact that it occurred but once in their series of 306 meningiomas.[1] When one considers the fact that meningiomas comprise about 10 to 15 per cent of intracranial tumors and that the latter in turn occur in less than 2 per cent of autopsies on tumor cases, it is evident that this type of growth is rare. Nevertheless, a sufficient number of reports have appeared to establish this lesion as a distinct clinical entity. The report of de Busscher,[2] in 1939, mentioned sixteen previous cases of cerebral convexity chondroma noted in the literature. To these should be added the basal tumor of Cushing and Eisenhardt and the two intraventricular chondromas reported by Letterer.[3] The former case, though differing from the others in its basal location, appears to belong to this group rather than to the basal chondromas and osteochondromas of bone for no bony attachment could be demonstrated. This growth presumably took origin from the outer end of the superior petrosal sinus. Since the choroid plexus arises as an invagination of the primitive leptomeninx into the attenuated ependymal surface of the primary brain vesicles, such tumors occurring within the ventricles can be considered as of meningeal origin, and therefore as a variant in this group.[4]

Chorobski, Jarzymski and Ferens[5] carefully culled the literature in reporting a case in which operation was successful, bringing the total number of instances of intracranial chondromas and osteochondromas to twenty-five. Among the previously reported cases, both osteochondromas and chondromas have been noted, with the pure chondromas more numerous. Two were sarcomatous lesions or at least recurrences.[1,6] It is of importance that these tumors be distinguished from other reported cases[7,8] of chondromas of the base of the skull secondarily involving the brain, where the tumor is extradurally situated and arises from bone. The origin of such cartilaginous growths is more easily explained than that of the intradural variety.

As has been pointed out, however, this type of tumor is not limited to the convexities. Regardless of site, all have in common a meningeal attachment. They are encapsulated, and although they compress the brain markedly, do not invade it, unless sarcomatous change is present. Occasionally, the dura overlying the tumor is in turn firmly attached to the skull.

The following case is the twenty-sixth of its kind recorded in the literature, the sixth in which complete, successful removal of the growth was carried out:

CASE REPORT

CASE 1. (Q. G. H. #A26903). J. M., an eighteen year old white male, was admitted to the Queens General Hospital on January 16, 1941. He complained chiefly of convulsive seizures of four months' duration. There was a total of five paroxysms during this period. With one exception they were all of a completely generalized pattern, without aura, comprising tonic and clonic features and lasting about twenty minutes. The second attack

* From the Departments of Surgery (Neurosurgical Division) and Pathology, Queens General Hospital, Jamaica, Long Island, N. Y.

appears to have been initiated by a feeling of stiffness in the right upper limb which subsequently went on to a generalized seizure. Both

FIG. 1. Radiograph of skull showing ovoid, mottled, calcified tumor shadow.

the patient and his mother were aware of a progressive inability on his part to concentrate satisfactorily on his school work for the previous five years. For about a year prior to admission it had been observed that the patient was inclined to be more irritable than was his custom, became increasingly wayward and would stay out exceptionally late at night. An intermittent droop of the right upper eyelid had been noticed during the nine months' period prior to admission.

The patient played a considerable amount of football since the age of twelve. In the course of play he sustained numerous injuries to the head, to which little attention was paid. The injury would, as a rule, daze him momentarily, after which he would continue to play. A month before the development of his seizures he was assaulted and apparently struck on the head, following which he was unconscious and drowsy for about three hours. Subsequently, however, he was able to be up and about in his customary manner.

Examination revealed nothing of significance with respect to the systemic status. Neurologically, one could demonstrate no frank abnormality, apart from an evident psychomotor retardation of slight degree. Otherwise, there was no disturbance of affect, memory, orientation, speech function, cranial nerve innervations, co-ordination, sensation, reflexes or motor power. The patient was right-handed.

Laboratory Data. These showed nothing of particular significance in the blood count, serology, blood chemical studies or urinalysis.

FIG. 2. Air studies showing displacement of ventricles by rounded, calcified tumor mass.

Cerebrospinal fluid study revealed clear, colorless fluid under a pressure of 170 mm. of water with no cells and a protein of 40 mg. per 100 cc.

X-rays of the skull revealed an elliptically-shaped, well demarcated, calcific shadow, situated within the intracranial cavity on the right side, near the inner table of the skull and measuring 2½ by 2 inches. (Fig. 1.)

Since the clinical picture suggested that the shadow noted by *x*-ray might represent calcification within an old hematoma, it was decided to ascertain this possibility through visualization of the ventricular system. Accordingly, pneumo-encephalographic study was carried out. This revealed an appreciable shift of the lateral and third ventricles to the left, without much distortion of the ventricular system. (Fig. 2.) The normal convexity of the roof of the right lateral ventricle was not appreciably altered. This combination of data suggested that a calcified hematoma was unlikely and that the lesion was in all probability an astrocytoma.

Operation. A right lateral osteoplastic craniotomy was carried out under avertin-ether anesthesia. While the bone flap was being

reflected, it was found quite adherent to the dura mater along the groove of the middle meningeal artery. The dura in this region was not unlike the aura of the second of the patient's convulsions. No convulsion appeared on this occasion, however. Both the patient and

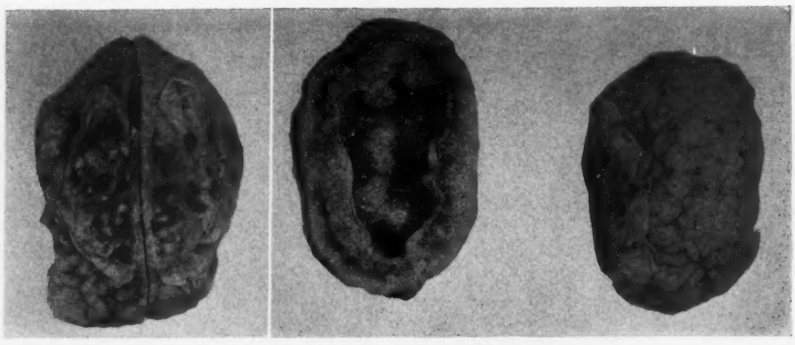

Fig. 3. Fig. 4.

Fig. 3. Tumor mass (halved by longitudinal section) showing coarse lobulation and finer linear cerebriform superficial gyration.

Fig. 4. The lateral and medial aspects of sectioned tumor. The lateral aspect shows the surface lobulation and gyration and the attached dura. The medial aspect shows the central cavity and the encircling zone of more opaque and congested and somewhat hemorrhagic zone of calcification.

appreciably thickened and it was evident that a tumor mass firmly adherent to it, lay directly underneath. Opening the dura revealed a tumor, the size and shape of a lemon, in the Rolandic zone. This was largely covered by brain, but nevertheless extracerebral. It was white, glistening, hard, and had a cerebriform

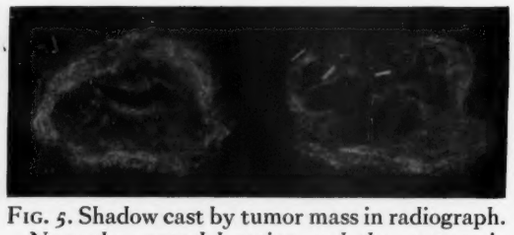

Fig. 5. Shadow cast by tumor mass in radiograph. Note the central location and the concentric encircling character of the zone of calcification. The central area corresponding to the cyst structure is free of calcification.

convolutional nodularity. The mass with its attached dura was gradually shelled away from the surrounding brain, leaving a deep tumor bed. By the time closure was begun, the brain at this site had re-expanded considerably. A dural defect about 2 inches in diameter was left behind. The dura was sewn to the galea at the bone edge. The bone flap was sacrificed in view of the possible involvement of the inner table. The wound was closed in layers without drainage.

The postoperative course was uneventful, except for an isolated episode on the seventh postoperative day, when the patient experienced a sensation of stiffness in the right hand, his associates were aware of steadily increasing alertness in him. At the time of discharge it appeared that he had attained his former mental state.

Pathological Report. Gross Description: The specimen (Fig. 3) consisted of a lemon-shaped mass measuring 7 by 4 by 4½ cm. and weighed 90 Gm. The external surface was irregularly nodular and lobulated in appearance and very firm. On one surface, a flattened membrane composed of opaque, grayish, fibrous tissue suggested dura and showed some hemorrhage. Four silver clips were seen around the periphery. The tumor mass was firmly adherent to the inner surface of this membrane. The inner surface of the fibrous tissue membrane was reflected over the presenting surface of the large tumor mass, but was firmly adherent as an integral part of the exposed surface.

The mass, on section, (Fig. 4) was composed of a dense wall 1 cm. in diameter, irregular in outline, with a central cystic cavity 4½ by 2 cm. The wall was composed for the most part of a translucent, opalescent, firm, bluish-gray tissue resembling cartilage. A centrally placed encircling rim of calcified tissue which grated and cut with difficulty divided the wall into three distinct layers, the opaque zone of calcification appearing in sharp contrast to the translucent peripheral gray cartilage to either side of it. The presence of calcification was confirmed by *x*-ray. (Fig. 5.)

The cystic cavity was lined by a yellow, glary, thin, transparent membrane through

which protuberant cartilaginous nodulations of the wall could be seen. From the wall of the cavity, thin, filmy, yellowish strands projected, which contained in their webs glary, somewhat viscid, yellowish, mucoid material.

Fig. 6. Low power microphotograph showing superficial attached dura, wide zone of cartilage with varying degenerative changes, adjacent calcification and true cancellous bone formation on the innermost aspect with included fatty marrow.

Fig. 7. High power microphotograph showing varying character of cartilage cells and their grouping with adjacent calcification and bone formation.

Microscopic Description: Microscopic sections (Figs. 6 and 7) showed the major portion of the tumor tissue to consist of hyaline cartilage with areas of degeneration and ossification. The cartilage cells were rather hypertrophied with some zones showing myxomatous material, and other areas showing distinct calcification. Centrally placed degenerative areas showed irregular calcification with transformation to true bone. The matrix separated some cell groups widely. At the periphery only a small island of ossification was seen. Some true fatty marrow without hematopoietic foci was included between the cancellous bony trabeculas.

The attached dural membrane showed some hemorrhage and was closely approximated to the perichondrium-like capsule of the tumor tissue. One small island of cartilage extended into the dural membrane, resembling the manner of extension seen in Pacchionian arachnoidal granulations.

The central cystic cavity showed an outer, rather dense, fibrous, lamellated, eosinophilic coating applied to the cartilaginous tissue and an inner thin, fragile, membrane-like lining. Nondescript loose strands of tissue were found in this area with relatively few cells and no distinctive histological appearance. In multiple sections, no cellular lining was made out delineating the central cavity.

Pathological Diagnosis: Dural chondroma with ossification, marrow formation and cystic degeneration.

ORIGIN AND CLASSIFICATION

The possible origin of this particular growth has invited considerable speculation and is as yet unsettled. The possibility of origin from cartilaginous rests misplaced during the complex development of the skull has been considered. Their existence within the meninges, however, is somewhat dubious. It is on this basis that Wolf and Echlin[6] question the likelihood of a meningeal origin and suggest the calvarium as a more plausible possibility. In nearly all the reported cases an intradural attachment was demonstrable and in only two[9,10] was

there an evident connection and attachment to bone, suggesting origin from this tissue.

There do exist theoretical possibilities for the meningeal origin of such tumors. Alpers[11] has shown transitions from meningeal fibroblasts to cartilage cells. He assumes that in this variety of tumor, fibroblasts are "activated" to produce cartilage cells. Included in our own histological sections, spindle-shaped cells with other features of cartilage and a surrounding cartilaginous matrix were observed. Persistent young mesenchyme or tangentially differentiated fibroblasts of the meninges may be the source of chondromas attached to the dura, by this theory. In the literature, associated though not demonstrably causative trauma is noted rather frequently.

In some of the hypertrophic Pacchionian granulations, a scant matrix with a distinct resemblance to cartilage can often be seen. Most authors accept such cell nests in the arachnoidal granulations as the origin for meningiomas. Complex tumors of cartilage with calcification, bone and fat content are usually basically chondromas with secondary changes, a known propensity of chondromas throughout the body. Calcification, ossification with marrow formation, occasionally with active hematopoietic foci, various stages of degeneration and cyst formation, are all quite common in the general pathological variations of such cartilaginous neoplasms.

The term, intracranial chondroma, is sufficiently noncommittal but does not serve to distinguish this lesion from other varieties, such as those chondromas of the base which definitely arise from bone. Practically all the described cases are of growths in association with the meninges. By this concept, tumors occurring intraventricularly can be considered as of meningeal origin, for reasons already mentioned. For the present, pending further additions to our knowledge of this growth, the suggested chondroblastic meningioma would appear to satisfy both regional and histologic criteria of classification.

CLINICAL CONSIDERATIONS

A preoperative histologic diagnosis of this type of lesion, such as is possible in some other varieties of brain tumor, is not to be expected. The condition occurs in children, adolescents and adults. Its symptoms and signs do not differ materially from those of other types of intracranial tumor. The clinical course may be of long or short duration, the latter probably being more typical of those characterized by sarcomatous elements. The presence of an *x*-ray shadow does not serve to distinguish the lesion from other types of tumor capable of undergoing calcification, such as the astrocytoma, meningioma or oligodendroglioma. In this particular case the nature of the *x*-ray shadow suggested an astrocytoma. Considered in retrospect, one might say that the calcification visualized here was exceptional in density and extent. The pneumo-encephalographic picture was of interest in that the distortion and displacement of the ventricular system was considerably less than the large size of the tumor would ordinarily have led one to expect, this being consistent with the presence of a growth of long standing.

The prognosis is a relatively favorable one, complete and successful extirpation of this type of tumor having been carried out in six of the twenty-six reported cases. Its successful removal carries certain considerations based on the nature of the lesion. It is obviously important that the growth be recognized when encountered. This should not be difficult, even with biopsy study not immediately available. The solid, smooth, white, marble-like character of the tumor with its firm dural attachment is practically unmistakable. Frequently, the dura is in turn firmly attached to the inner table of the skull, as was found in this case. The tendency toward recurrence and the occasional presence of sarcomatous change, make necessary a complete removal of the tumor

with its capsule, as well as a liberal portion of dura beyond its attachment to the neoplasm. The same reasons that compel a complete excision of the growth suggest the need for removal of the overlying bone, even if an endostosis cannot be demonstrated.

The dural defect, even if large, need not be repaired, since connective tissue regrowth may be expected. To circumvent the possibility of a cerebrospinal fluid fistula in the presence of a large dural defect, the wound should be closed securely without drainage. Dural hemostasis must, therefore, be thorough and is probably best accomplished by approximation of the dura to the overlying temporal muscle and periosteum at the bone margin.

SUMMARY

1. A case of chondroblastic meningioma, the twenty-sixth to be recorded in the literature, the sixth with complete operative removal, is presented.

2. The origin, classification and clinical aspects of this type of growth are briefly discussed.

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ANORECTAL AND COLONIC MANIFESTATIONS OF SCHISTOSOMA MANSONI INFESTATION (INTESTINAL BILHARZIA)*

CASE REPORT

BENJAMIN W. WARNER, M.D.
NEW YORK, NEW YORK

SCHISTOSOMIASIS mansoni is an endemic tropical and subtropical parasitic disease caused by a blood or fluke worm (Schistosoma mansoni) which spends part of its intermediate life cycle in a snail. It gains access to its human host in its larval stage from infected water. The larvae penetrate the skin or buccal mucous membrane and then enter the peripheral veins; after passing through the pulmonary circulation they arrive in the systemic circulation and are carried into the superior mesenteric artery and its branches and then into the portal venous system; they feed and grow in the intrahepatic branches of the portal vein. In their mature form the parasites migrate to the terminal tributaries of the superior and inferior mesenteric veins where copulation and egg-laying occurs. The extrusion of the eggs from the venules produces local pathologic tissue changes and systemic toxic manifestations.

The disease is endemic in Egypt, Central and West Africa, the East Coast of South America, the West Indies and especially in Puerto Rico. With increased travel, population shifts, the establishment of military bases in subtropical and tropical climates, parasitic diseases endemic in those areas will be brought to our attention with increasing frequency.

CASE REPORT

Mrs. D. S., age twenty-six, was born in Puerto Rico and lived there in a rural area, Bonito, until six years ago when she came to New York City. She had been married for five years and had no children. She was first seen in the gynecology clinic of Beth David Hospital in February, 1941, complaining of sterility and intermittent pain in her left lower quadrant, unrelated to menstruation. A mass in the left adnexa was palpated. In June, 1941, after several months of observation she was hospitalized on Dr. Mortimer Hyam's service. The routine laboratory findings were as follows: hemoglobin 65 per cent, erythrocytes 4,670,000, leucocytes 8,600 with 78 per cent polymorphonuclears and 22 per cent lymphocytes. There were no eosinophiles. Urinanalysis was negative. Blood Wassermann: alcohol antigen 1 plus, cholesterol antigen 2 plus.* A laparotomy was performed by Dr. Moses Lobsenz. A left tubo-ovarian mass the size of a small peach was found and a left salpingo-oophorectomy and appendectomy were performed. The pathologic diagnoses were: chronic salpingo-oophoritis, corpus lutean cyst of the ovary, atrophy and fibrosis of the appendix. In the appendix slight cosinophilic cell infiltration of the muscularis was noted.

Convalescence was uneventful. Upon her discharge from the hospital she returned to the gynecology out-patient department for follow-up care and complained of slight rectal bleeding, pain and itching. She was then referred to the rectal clinic.

Rectal examination revealed an inflamed, tender posterior anal crypt with a posterior fissure-in-ano and slightly enlarged internal hemorrhoids. Sigmoidoscopy revealed a sessile, elevated pea-sized nodule, diagnosed preoperatively as an adenoma, in the mucous membrane of the posterior rectal wall about four inches above the anus and multiple small papillomas in the vicinity of the rectosigmoidal junction.

* It was learned later that she had been treated for lues several years previously by a private physician who had found a four plus Wassermann reaction.

* From the Proctology Service of the Department of Surgery, Beth David Hospital, New York City. Dr. Frederic W. Bancroft, Director of Surgery, Dr. I. M. Brenner, Attending in Proctology. Read before the Beth David Hospital Clinical Society November 17, 1941.

There was a small area of granulation tissue 5 mm. in diameter on the anterior rectal wall. The sigmoid above the rectosigmoidal junction appeared normal.

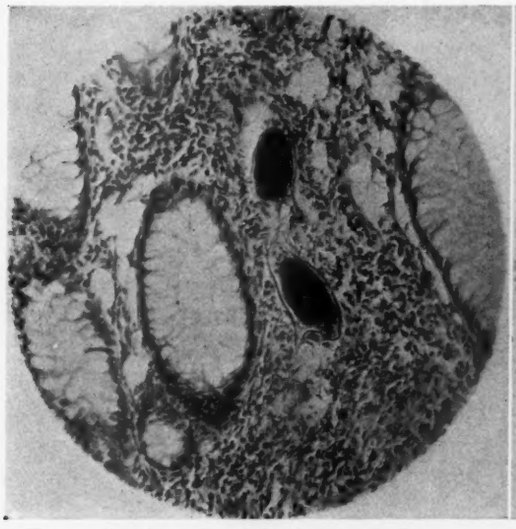

Fig. 1. Section of nodule showing inflammation with mononuclear and polymorphonuclear leucocytes and eosinophiles. Two oval-shaped ova of Schistosoma mansoni with a typical lateral spine are seen. (High power.)

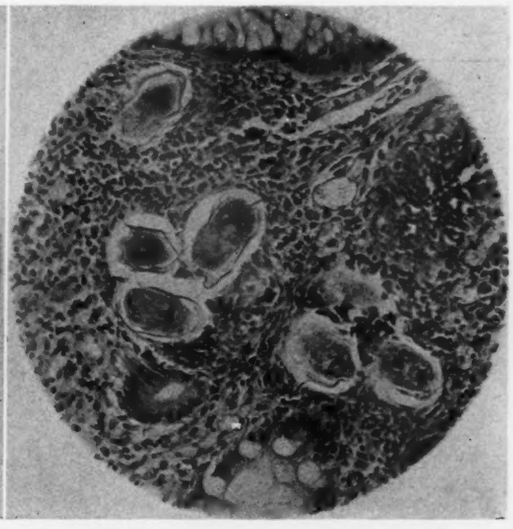

Fig. 2. Section of anal crypt showing inflammation and many distorted ova of Schistosoma mansoni. (High power.)

The patient was hospitalized again on September 12, 1941. Laboratory findings were as follows: hemoglobin 97 per cent, erythrocytes 4,750,000, leucocytes 8,460 with 72 per cent polymorphonuclears, 27 per cent lymphocytes and 1 per cent monocytes; urinanalysis was negative. Stool examination was not done. Under local anesthesia the sessile nodule was removed with the electric cutting loop and the smaller papillomas coagulated; the posterior anal crypt and fissure were excised. Routine histologic examination of the tissue by Dr. Milton Helpern was reported as follows:

"There is a moderate inflammation in the mucosa and submucosa; the inflammatory cells are mononuclear and polymorphonuclear leucocytes and eosinophiles. The sub-mucosa contains dilated venules. In some section there are oval-shaped parasitic ova possessing a typical lateral spine. In one section a group of such ova is surrounded by numerous eosinophiles.

"Diagnosis: chronic inflammation of anal mucosa resulting from infestation with parasitic ova of Shistosoma mansoni. (Schistosomiasis mansoni.)" (Figs. 1 and 2.)

With the finding of the ova of Schistosoma mansoni the histologic sections of the tube, ovary and appendix previously removed were re-examined but no ova were found. Unfortunately, the gross specimens had been discarded so that more sections could not be made. The appendix is a fairly frequent site of involvement and cases of fallopian tube infestation[1] have been reported.

The patient's convalescence was uneventful. She was discharged from the hospital in five days and returned to the clinic. The posterior anocutaneous wound developed excess granulation tissue which was curetted and examined histologically but ova were not found. Sigmoidoscopy revealed the mucous membrane of the rectum and sigmoid studded with punctate bleeding areas which were interpreted as points of rupture or escape of the ova into the lumen of the bowel. Repeated stool and direct rectal smears revealed an occasional distorted ovum.

A blood count on Octover 10, 1941, revealed: hemoglobin 97 per cent, erythrocytes 4,920,000, leucocytes 11,900 with 59 per cent polymorphonuclears, 28 per cent lymphocytes, 7 per cent eosinophiles, 3 per cent monocytes, 2 per cent basophiles. This was the first appearance of eosinophilia. At this time there were numerous bleeding areas in the mucous membrane of the rectum and sigmoid. There was no diarrhea. A barium enema did not reveal any additional findings in the colon.

A chest *x*-ray on this date revealed multiple small areas of infiltrations at the right apex which were absent on a subsequent *x*-ray one month later. It is probable that these infiltra-

tions resulted from a Schistosoma invasion of the lungs.

At the present writing the patient feels well

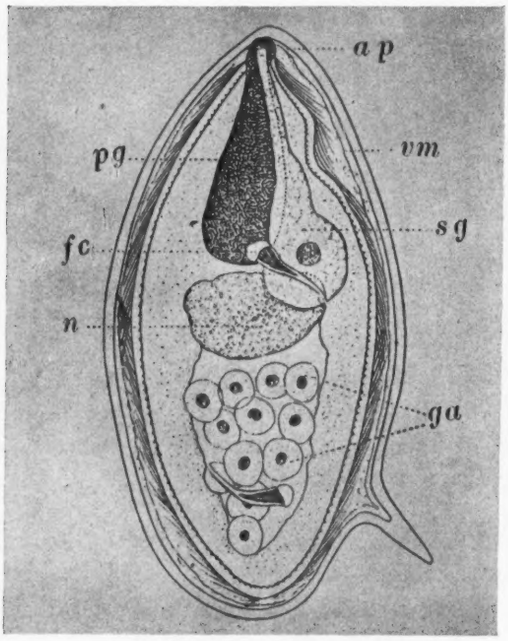

Fig. 3. Typical lateral-spined ovum. (From Faust, after Cort; courtesy of the Univ. of California Press.)

and has no complaint other than slight peri-anal itching. Objectively, the sigmoidoscopic findings persist. The spleen is just palpable but the liver is not. Treatment with fuadin (sodium antimony[111] biscatechol 2.4 disulfonate of sodium) intramuscularly has been started.

The cause of human Schistosomiasis involving the urinary bladder with hematuria as its outstanding symptom was recognized and described by Dr. Bilharz in Egypt in 1851 and this disease bears his name. For many years all types of human Schistosomiasis were called Bilharzia until attention was called, in 1893, by Dr. Manson to the morphologic difference in the ova from an essentially intestinal type of the disease. In this type ova with a lateral instead of a terminal spine were identified. Schistosoma producing the lateral-spined ova have a different geographic distribution and produce a different visceral involvement and carry the name of Manson. (Fig. 3.)

The life cycle[2] of the parasites in the vesical and the intestinal type of Schistosomiasis are similar differing only in their final localization in the veins of the portal system; both types produce similar pathological changes in the host but in different viscera. Schistosoma mansoni eggs are discharged from their human host in feces, occasionally in urine. Careless toilet habits and faulty sewage disposal result in the contamination of bodies of water which are also the suitable environment for a specific species of snail (P. guadaloupensis) which acts as an intermediate host. The ovum when discharged in the water liberates a miracidium which enters the snail's visceral mass where it multiplies and grows, giving rise to another intermediate larval stage, the cercariae, which possess a long tail. The larvae in the cercarial stage leave the snail after four weeks and move actively in the water; they can survive from one to three days if they do not find an appropriate human host. On making contact with the exposed skin or buccal membrane of their human host, they penetrate the skin or mucous membrane, their tails drop off and within one-half to one hour they penetrate to the deeper layers. Infestation cannot occur by oral ingestion as the larvae cannot survive the action of gastric juice. From the deeper layers of the skin the larvae enter the peripheral venules, are carried to the right heart and thence to the pulmonary capillaries.

"The larvae having reached the pulmonary capillaries squeeze their way through, enter the left heart, systemic circulation, abdominal aorta and superior mesenteric artery. Only those larvae survive which enter the superior mesenteric artery. Thence they are carried through the capillaries to the superior mesenteric vein and enter the intrahepatic radicles of the portal vein where they feed on red blood cells, become sexually differentiated and mature. On reaching maturity, the adult worms move against the portal blood stream to the ileocolic and colic branches of the superior mesenteric vein and wander into the anastomoses of the venous circulation toward the lower branches of the inferior

mesenteric vein especially in the hemorrhoidal plexus in the Mansoni type and in the vesical plexus of veins in the Bilharzia type. This growth and migration of the adult worm takes about six weeks from the time of entrance of the larvae into the skin. In the venous plexus copulation occurs and the female then makes her way into the smallest venule which becomes distended and there deposits her lateral-spined eggs one at a time from one to several hundred per day, moving to a new site for each egg. The distended vein tends to return to normal caliber; the spine of the egg penetrates its wall and by both mechanical and lytic digestive action perforates the vein and is either extruded into the lumen of the viscus, the sub-mucosa or the peritoneal surface or peri-rectal tissues. The eggs discharged into the lumen of the bladder or rectum are excreted in the urine and feces and if a body of water containing an appropriate species of snail is contaminated, the snails become infected and the cycle begins again in the intermediate host."[2]

The entrance of the larvae into the skin is accompanied by an intense pruritus spoken of by the natives of Puerto Rico as "piquina." This may last several hours to several days. There is a type of Schistosoma in snails in resort lake regions of Michigan and Minnesota which penetrates the skin of bathers and sets up an intense skin rash with itching called "swimmer's itch"[3,4] but fortunately the larvae in these cases are destroyed in the deeper layers of the skin and do not enter the circulation. There are no reports of cases in residents of the United States who have never left this country. An infection is reported[5] in a resident of the United States who dipped his hand into a home aquarium which contained a species of the snail transmitting the Egyptian type of Schistosomiasis.

With promiscuous distribution of human excreta and improper sewage disposal in the tropics and especially in Puerto Rico where the rural areas are studded with irrigation ditches with stagnant water and slow moving rivers, as well as lime stone pools offering a suitable environment for the appropriate species of snail, the incidence of Schistosomasis mansoni in the general population is about 12 per cent, while in certain endemic areas the incidence of infestation reaches 50 to 60 per cent.

The clinicopathologic picture and symptomatology are classified by Craig and Faust[2] into three stages: "(1) invasion and incubation period—six to seven weeks; (2) egg deposition and extrusion; (3) tissue proliferation and repair." A diagnosis is seldom made in the first stage although there may be symptoms of mild toxemia and occasionally diarrhea of supposedly toxic origin. It is during the second stage of egg-laying and extrusion which occurs from five to seven weeks after exposure that local abdominal or intestinal and systemic toxic symptoms make their appearance. There may be a sudden onset with temperature, chills and sweating, abdominal pain with tenderness along the colon, dysentery with passage of blood and mucus with lateral-spined ova in the stool, dry cough and even parenchymatous infiltration especially of the apices, urticaria, enlargement and tenderness of the liver and later splenic enlargement. There is leucocytosis and eosinophilia.[2,6,7]

With subsidence of this acute phase which may have varying degrees of severity, proliferative and reparative tissue changes occur. These granulomatous inflammatory changes depend upon the location of the adult worm and the site of egg extrusion and may appear clinically as superficial ulcerations with granulations, papillomas and pseudo-adenomas (sessile or polypoid). The ova may be extruded to the peritoneal surface of the bowel producing pseudotubercles or into the perirectal tissues with resultant fistulas. Fistulization may occur from any part of the involved bowel. The granulomas in the lumen of the colon and rectum may become polypoid and produce the same sequence of symptoms and complications common to all polyps. Malignant degeneration in the

granulomas is not rare.[2] If the polypoid granulomas are located in the rectum or anal canal, they may prolapse through the anus. The cryptitis is due to the presence of the ova; hemorrhoidal vein engorgement may result from obstruction of the venules by the adult parasites and from interference with lymphatic and venous circulation due to local inflammatory infiltration and obstruction of the portal circulation where liver enlargement and subsequent cirrhosis occurs.

In this connection a report by a Cairo surgeon, M. Samy,[2] on "Bilharzial Piles and Anal Fissure" is interesting: "In the routine examinations and treatment of piles the author has met with a peculiar kind of piles which deserve a special treatment. The patients suffering from this kind of piles are mostly from the country and suffer from all the usual symptoms of piles. Some intelligent patients may give a history of a severe fever, sometimes amounting to 40 degrees c. or more, accompanied by an urticarial rash, acute abdominal pain, rigors symptoms of pulmonary congestion and profuse sweating. This may be accompanied by some diarrhea. After about three months from the fever the local symptoms of piles begin to appear. If they are operated on they recur unless systemic treatment is instituted."

The diagnosis of Schistosomiasis mansoni infestation is made from the history of travel in an endemic area, finding the ova in the stool or peri-anal or rectal swabs,[2] and tissue biopsy. The serologic tests are not developed sufficiently to be of value for general usage as diagnostic aids. In the acute or open stage of active egg extrusion the eosinophilia, urticaria and dysentery may indicate the diagnosis but it is also at this stage that typhoid, tuberculosis and malaria are frequently incorrectly diagnosed. In the proliferative stage sigmoidoscopy may be of great value with biopsy of any granulomatous tissue seen. As the infection becomes more chronic, eggs in the feces gradually decrease in number.[2]

SUMMARY

A case of Schistosomiasis mansoni infestation in a native Puerto Rican, now living in the United States, with predominant anorectal manifestations is reported. Physicians should be on the alert to suspect this infestation in soldiers and workers who return from their stations in Puerto Rico and other endemic areas and present anorectal and intestinal symptoms with or without enlargement of the liver and spleen. Eosinophilia is inconstant and usually absent in the late stages. Pulmonary infiltrations may be confusing unless the infestation is suspected.

While mention of a third type of pathogenic human Schistosomiasis was not intended for this report, it is now pertinent to make note of Schistosoma Japonicum infestation which is endemic in and about China and Japan. This Schistosome involves the small bowel with severe systemic toxic symptoms.

I am grateful to Dr. Milton Helpern and Dr. Alfred Gudemann of the Pathology Department of Beth David Hospital for their kind assistance in preparing this report.

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A RARE COMPLICATION OF THE MILLER-ABBOTT TUBE*

LOUIS R. KAUFMAN, M.D.,
Professor of Surgery, New York Medical College

SABATO SERPICO, M.D.
Assistant Attending Surgeon,
Flower and Fifth Avenue Hospitals

AND

WALTER MERSHEIMER, M.D.
Chief Resident in Surgery, Metropolitan Hospital
NEW YORK, NEW YORK

TRAUMATIC edema of the larynx produced by the Miller-Abbott tube is a rare complication and seems worthy of reporting.

As the simple but important steps in the introduction and passage of the Miller-Abbott tube have become more familiar to us, we have come to depend upon its more frequent use for decompression in a large group of cases. These include the more serious acute obstruction but also elective resections, as well as the border-line cases presenting a degree of abdominal distention demanding laparotomy. In this latter group the use of the tube may permit not only valuable preoperative preparation but may even avoid the necessity for intervention.[1–6]

Conservative decompression in intestinal obstruction in contrast to surgical decompression (enterostomy) constitutes an important contribution to the reduction of mortality in this group of cases.

Before the advent of the inlying suction tube, the death rate in intestinal obstruction averaged from 60 to 75 per cent. (Best[7] gives the following figures: Guillame 63.2 per cent; Arhurst 69.3 per cent; Lee and Downes 75.0 per cent; C. J. Miller 61.0 per cent.) Since the advent of the Miller-Abbott tube Whipple[20] states that the mortality has been reduced 50 per cent in intestinal surgery. Johnson, Penberthy, Noer and Kenning[13] have reported a mortality of 25.6 per cent. Of fifty-four patients treated by intubation, five or 9.3 per cent died as a result of intestinal obstruction, while in the remaining nine who also died, intubation was carried out to relieve distention associated with other conditions which caused death. The University of Minnesota has reported a patient mortality of 17.9 per cent and a case mortality of 14.7 per cent.

In our service, we have employed the Miller-Abbott tube in approximately seventy-five cases. No important complication has followed its use which we believed could in any way be attributed either to the passage of the tube or to its continued use over many days. Few of the patients have complained of any particular discomfort.

C. G. Johnson[15] says that: "The tube occasionally causes irritation to the nose and throat. We had one patient who developed otitis-media during treatment, and another in which there was a rupture of esophageal varices presumably from trauma by the tube." Morawitz and Henning[17] report that some patients complained of pharyngeal irritation which disappeared when a thinner tube was substituted and Morrison states that "cricoid chondritis may occur when a rubber feeding tube has been retained in the esophagus for long periods." O. H. Wangensteen[19] et al. state, "Two patients have been observed with injury of the arytenoid cartilages following prolonged intubation. One of these was our own patient. The other patient was admitted here with edema of the arytenoid cartilages and larynx for which tracheotomy was done." Iglauer and Molt[13] have found that severe injury to the larynx is

* From the Department of Surgery, New York Medical College, Flower and Fifth Avenue Hospitals and Metropolitan Hospital.

occasionally excited by the presence of the indwelling tube and that this complication may occur after a comparatively brief sojourn of the tube. They have observed ten such cases in two years. Eight of these patients developed laryngeal stenosis of such severity that tracheotomy became imperative. The tube was inlying for comparatively short periods varying from six to twenty days. The average period was eight and a half days. Laryngeal examination in the acute stage revealed evidence of inflammation and edema. The laryngeal inflammation was secondary to the presence of an indwelling duodenal tube. The primary lesion appeared to be due to pressure necrosis of the esophagus at its attachment to the body of the cricoid cartilage.

While some injuries are mild and even escape notice, others are severe enough to jeopardize the life of the patient, and may require an emergency tracheotomy (Wangensteen,[19] Iglauer and Molt[13]).

These injuries of course are not peculiar to the Miller-Abbott tube, but are common to any suction tube, as the casual factor is trauma. These injuries we believe would be more common were they looked for, but as Wangensteen[19] writes: "In as much as our pathologists do not examine routinely the nasopharynx, larynx and upper reaches of the esophagus, it is of course not likely that in this region, where such pressure effects are most likely to arise, several have escaped notice."

CASE REPORT

M. G., a seventy-eight-year old Spanish, white female, was admitted to the Metropolitan hospital on May 7, 1941.

Her chief complaint on admission was vomiting and generalized abdominal pain of three days' duration. Vomiting was green and followed each meal; pain was severe and colicky radiating to the right shoulder. The patient was a regular user of cathartics. No blood or mucus was found in the stools. An enema taken the night before admission was ineffectual. The important point in her past history was the fact that the patient was treated in another institution four years ago for "stone in liver" but was not operated upon because of poor general condition.

Physical examination revealed a white female, small of stature and somewhat obese, but apparently not acutely ill. The abdomen was distended and soft with slight tenderness throughout which was more marked over the right upper quadrant. Peristaltic sounds were heard with tympany. No rigidity, succussion splash, scarring or hernia were present. Rectal examination revealed no feces on the examining glove, or any intrinsic pathological condition. Tachycardia and moderate myocardial damage with generalized senile arteriosclerosis were present. One independent finding was that of an asymptomatic adenomatous thyroid.

Laboratory findings were as follows: The urine was negative; Wassermann and Van den Bergh tests were also negative; the icteric index was 6.1. The red blood cells numbered 4,740,000; hemoglobin 80 per cent; white blood count, 8,500; polymorphonuclears 88 per cent; lymphocytes 12 per cent; basophiles 4 per cent. The following is the blood chemistry report: Creatinin—0.9 per cent; urea nitrogen—11; sugar 105; chloride 605; protein 7.95–6.93; fibrinogen 0.57–0.31; albumin 4.34–3.74; globulin 3.06–2.90.

X-ray studies by our surgical and *x*-ray residents were made by injection of barium through the Miller-Abbott tube which made possible the visualization of the entire intestinal canal from the jejunum to the sigmoid and showed no obstruction or intrinsic pathological condition. The flat *x*-ray plate was negative; there was no evidence of intestinal obstruction or radio-opaque calculi.

The impression was: (1) Acute cholelithiasis and cholecystitis; (2) possible malignancy of hepatic flexure of colon and (3) partial intestinal obstruction.

Conservative treatment was instituted as follows: passage of Miller-Abbott tube, high colonics, intravenous fluids and blood transfusions continued until May 19, 1941. On that date there was sudden dyspnea, cyanosis with a rapid irregular pulse. Inspiratory crow was present. No evidence of pulmonary changes was found to account for the dyspnea. Laryngoscopy was performed showing definite edema of the cords. The patient was first intubated and then an emergency tracheotomy was performed. Her general condition improved and the patient

was receiving supportive treatment when she became toxic and died on May 22, 1941.

Postmortem Findings. There was generalized moderate atheromatosis, and slight congestion in the lower lobes and congestion of bronchial mucosa. The gallbladder was normal in size but filled to capacity by a large number of facetted, dark-green brown stones. The liver showed cloudy swelling. The kidney was congested but was otherwise normal. The thyroid weighed 200 Gm. and was markedly enlarged and nodular. One section of the thyroid was composed of cystic adenomas. There was extensive hemorrhage into the adenomas of the left lobe so that practically the whole lobe was infiltrated with blood. In the posterior portion of both lobes there was a large amount of bone formation as evidenced by brittly resistance meeting the knife as the organ was sectioned.

There was edema of the pillars of the larynx. The vocal cords appeared normal and the larynx showed a small amount of congestion. However, just below the vocal cords there were several small areas of mucosa covered by fibrin. The mucosa of the trachea became progressively more hyperemic and inflamed as one progressed toward the bifurcation at which point the inflammatory process was quite severe. The third, fourth and fifth tracheal cartilages were sectioned in their midportion. The mucosa of the trachea surrounding the tracheotomy wound was intensely congested and there was a small amount of purulent material covering the area. Further down the trachea, there were also several rather extensive areas covered by fibrin and some purulent exudate.

The presence of an extensive hemorrhage in the adenoma of the left lobe of the thyroid and the edema of the pillars of the larynx were noteworthy findings in view of the absence of a competent cause for these findings except the trauma of the tube. The extensive hemorrhage into the adenoma of the left lobe of the thyroid we believed was due to surgical procedure employed to reach the trachea. A spontaneous hemorrhage into the adenoma before the tracheotomy was performed was possible, but although spontaneous hemorrhages do occur, they are seldom of such severity as to require tracheotomy (Hertzler,[12] Boyd,[8] Crotti[10]). Spontaneous hemorrhage is more common in the fetal adenomas (Hertzler)[12] but there is little doubt that very many of the nodular adenomas commonly regarded as fetal in type are essentially the same character as colloid adenomas. According to Boyd:[8] "It appears that it is a mistake to draw any fundamental distinction between the colloid and fetal types of adenoma." These hemorrhages are of pathological rather than surgical interest. W. C. McCarthy[16] has never seen a hemorrhage into a fetal adenoma extensive enough to necessitate an emergency surgical intervention. A. Graham[11] believes that in the majority of cases hemorrhage into the fetal adenomas is of no clinical significance. G. W. Crile,[9] in a clinical analysis of 20,000 thyroid operations makes no mention of hemorrhage into fetal adenomas as the primary reason for operative interference.

The second important anatomopathological finding is the edema of the larynx. Acute edematous laryngitis rarely occurs as a primary affection but is secondary to septic tonsillitis, pharyngeal phlegm, peritonsillar abscess, erysipelas, or Ludwig's angina. None of these was present in our case. We can also exclude any systemic affection, as specific fevers, diabetes, Bright's disease or alcoholism as contributing factors.

Prolonged intubation with suction can produce irritation of the nasopharynx (Johnston,[15] Wangensteen[19]). Indirectly also the tube may contribute to this edema, by allowing regurgitation of the acid stomach contents, and this by chemical action, together with traumatic effect of the tube, produce such acute dramatic respiratory embarrassment as to require tracheotomy. Examination of the larynx by Guedel Foregger laryngoscope was done before resorting to tracheotomy and demonstrated marked edema of the arytenoids with obliteration of the interarytenoid fossa.

CONCLUSION

Review of the literature reveals reports of nine cases of severe laryngeal injury requiring tracheotomy produced by inlying suction tubes. To these we add one case of acute edema of the larynx requiring tracheotomy produced by intubation with a Miller-Abbott tube.

We believe that careful daily inspection of the larynx should be performed in all patients requiring prolonged intubation with inlying suction tubes.

Edema may result not only from the trauma of the tube but also by reason of regurgitation of the acid stomach contents. In our case the degree of edema required immediate tracheotomy for control of asphyxia. Its sudden onset and intensity of obstruction would not seem to have been the result of the chronic long-lasting thyroid enlargement.

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ENTEROCYSTOMA WITH TWISTED PEDICLE

J. MURRAY BEARDSLEY, M.D.
Associate Surgeon, Rhode Island Hospital
PROVIDENCE, RHODE ISLAND

THE occurrence of enterocystoma has been noted by several authors although it is among the more uncommon of the mesenteric cysts. It may occur in any portion of the alimentary tract with the terminal ilium being the most common site.

In the past much discussion has been centered around its mode of origin but it is now generally agreed that incomplete involution of the omphalomesenteric duct is the true explanation of this type of cyst.

The following case is reported first, because of the rarity of the condition and second, it is of interest because the cyst had a well developed pedicle around which it had become twisted, giving rise to abdominal symptoms and signs suggestive of acute appendicitis. In this instance the pedicle arose from the mesenteric border of the bowel in contrast to the more common site on the antimesenteric surface.

CASE REPORT

M. D., an eight-year old, white female was admitted to the Rhode Island Hospital on June 29, 1940 with the chief complaint of pain in the right lower quadrant. The patient had been well until the morning of admission when she noted cramp-like pain of moderate severity in the midabdomen. This had persisted intermittently, becoming somewhat worse in the evening when the pain localized in the right lower quadrant. Relief from pain was obtained by keeping the legs flexed upon the abdomen. She had been nauseated but denied vomiting. Her bowels had moved normally the day previous to admission. There had been no urinary symptoms. Her past history was irrevelant.

Physical examination revealed a well developed and well nourished eight year old girl, alert and co-operative. She appeared moderately ill and apprehensive. Apart from hypertrophied tonsils general physical examination was not remarkable except for the abdomen. The abdomen exhibited spasm on the right side with localized tenderness at McBurney's point. Rebound tenderness was referred to the same region; no masses were noted on palpation. The white blood count was 18,400 with 96 per cent polymorphonuclear neutrophiles. Urine examination was negative except for an occasional white blood cell. Her temperature was 99.0°F., pulse 124 and respirations 24.

The diagnosis of acute appendicitis was made and the patient was taken to the operating room shortly after admission. (Fig. 1.)

The abdomen was opened through a right rectus, muscle splitting incision. A moderate amount of serous fluid was present in the peritoneal cavity. The appendix was delivered without difficulty and showed some evidence of peri-appendiceal inflammation but otherwise appeared normal. It was removed in the usual manner and the stump was carbolized and buried. The terminal ilium was explored and a tumor was encountered 6 inches from the iliocecal valve. It was of elastic consistency with a smooth surface and not adherent at any point. It was attached to the mesenteric surface of the ilium by a pedicle which was 1 cm. in diameter but widened out to 2 cm. at its attachment to the tumor. The tumor mass was estimated to be 4 cm. in diameter and was twisted on its pedicle with one complete turn. The blood supply did not appear to be completely occluded and there was no evidence of gangrene or necrosis although the tumor had a cyanotic appearance. Improvement in circulation was noted as soon as the torsion was relieved. The tumor was removed after transfixation of the pedicle. The wound was then closed in the usual manner. The postoperative course was uneventful. Culture of the fluid from the peritoneal cavity showed no growth of organisms.

Pathological Report. (Dr. Robert J. Williams.) "Gross Description: Specimen consists of a spherical cystic structure measuring four centimeters in diameter. It is filled with a thin cloudy fluid. The external surface, to which is attached a delicate pedicle, is gray, smooth and

glistening. The wall of the cyst is one to three millimeters in thickness and its inner surface is rough and ragged. (Fig. 2.)

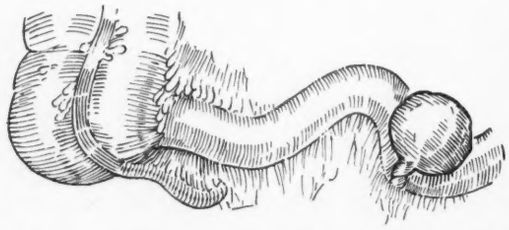

Fig. 1. Enteric cyst of terminal ileum twisted upon its pedicle.

"Microscopical Description: The cyst wall is composed of a well developed mucosa with a muscularis mucosa, sub-mucosa, a muscular coat composed of two layers of smooth muscle and a serosa.

"The mucosa is lined by a single layer of tall columnar epithelium with a cuticle-like border. Simple glands, opening by a short duct directly on the surface, are scattered irregularly throughout the mucosa. These glands are lined by a layer of epithelial cells similar to those on the surface. Occasional goblet cells are present. Lymphocytes and eosinophilic leukocytes are scattered through the mucosal stroma. The muscularis mucosa is absent in places. The smooth muscle fibres in the two layers of the muscular coat course at right angles to each other.

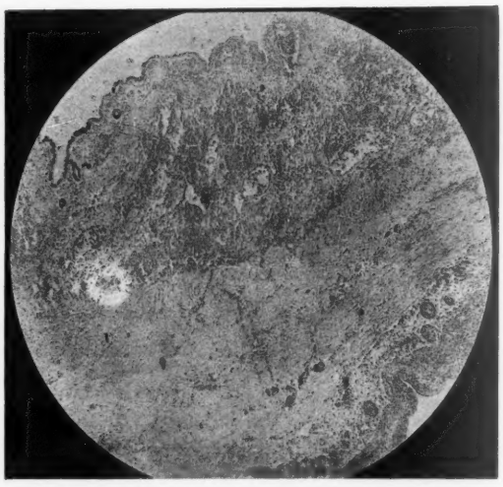

Fig. 2. Photomicrograph of cyst wall.

"In places there is ulceration of the mucosa and infiltration of all layers by an exudate of polymorphonuclear leukocytes, fibrin, erythrocytes and a few lymphocytes and large mononuclear cells.

"Diagnosis: Enterocystoma of ileum with acute inflammation."

RICHTER'S HERNIA*

CASE REPORT

EDWARD VERNON MASTIN, M.D.
Assistant Professor of Surgery, St. Louis University School of Medicine
ST. LOUIS, MISSOURI

THE following is a case report of Richter's hernia successfully handled:

CASE REPORT

A man, forty-five years of age, was admitted to the hospital with a history of pain and a tender mass in the right subinguinal region, which had been present for three days. He also complained of nausea and vomiting and inability to move his bowels during the last twenty-four hours. Examination showed a tender mass protruding from the right fossa ovalis. His temperature was 101.6°F., the pulse was 112 and his white blood count was 17,000. There was moderate abdominal distention. A diagnosis of strangulated femoral hernia was made, and immediate operation advised.

An incision was made below the inguinal ligament and the femoral sac was identified. The sac was definitely bluish red in color and upon opening it a half ounce of bloody fluid escaped. A portion of a loop of small intestine was seen protruding through the femoral canal. This was markedly swollen and definitely gangrenous. It was believed that the hernia could not possibly be reduced without rupture of the gangrenous area with associated contamination of the peritoneal cavity, so the only safe procedure was to establish an ileostomy by simple incision in the bowel through the gangrenous area and thus relieve the obstruction. The wound edges were protected by vaseline gauze and a small rubber tube was then placed in the lumen of the ileum.

The patient gradually improved and after two weeks the edges of the bowel appeared healthy and the wound was beginning to granulate. The patient was then given sulfanilaguanidine in doses of 15 gr., five times a day for one week prior to closing the ileostomy. A right rectus incision was made and the abdominal viscera adequately walled off and the loops of ileum proximal and distal to the ileostomy were identified. Two rubber-covered intestinal clamps were placed on each loop of the bowel about eight inches from the ileostomy opening. Then a small irrigating catheter was passed through the ileostomy wound by an assistant and each loop of bowel was thoroughly irrigated with a solution of sulfanilaguanidine. When it was believed that these loops were reasonably clean, all excess fluid was expressed and several abdominal pads were placed under the loop of ileum and the bowel was carefully separated from its attachment in the femoral canal. The edges of the opening in the ileum were then freshened and the opening closed transversely by two rows of sutures of chromic catgut, which were reinforced with several interrupted sutures of silk. The bowel was then cleansed with saline and replaced in the abdomen.

The attachment of the bowel in the femoral canal was cleansed and the peritoneum surrounding it was excised. Then this opening in the peritoneum was closed with chromic catgut. The abdomen was closed in a routine manner. A rubber drain was placed in the opening in the femoral canal and about a week later a secondary closure of the femoral canal was made.

COMMENT

The method described is a safe one for the treatment of a strangulated femoral hernia, as there is little or no risk connected with the operation. Too often when one attempts a primary resection of gangrenous bowel, when there is marked distention, due both to fluid or gas, the sutures do not hold and there will be a leak with resulting peritonitis.

* From the Department of Surgery, School of Medicine of the St. Louis University, St. Louis, Missouri.

EFFECT OF PREGNENINOLONE (ETHINYL TESTOSTERONE) UPON HUMAN CERVICAL SECRETION*

CHARLES H. BIRNBERG, M.D.,
Chief of the Department of Female Sex Endocrinology, and Associate Obstetrician, Jewish Hospital

LAWRENCE KURZROK, M.D.
Associate Obstetrician and Gynecologist, Greenpoint Hospital; Assistant Obstetrician and Endocrinologist, Jewish Hospital

AND

HENRY WEBER, M.D.
Assistant Obstetrician and Endocrinologist, Jewish Hospital

BROOKLYN, NEW YORK

IT has long been known that the cervical mucus is normally alkaline, and that penetration of sperm through the cervical secretion is apparently much better when this condition prevails than when the hydrogen ion concentration tends to be more acid. Efforts up until this time to change the acidity of cervical mucus from a hydrogen ion concentration of 5 to 6 to that of an alkaline hydrogen ion concentration of 8 have not met with much success. An acid cervical mucus is a deterrent to semen penetration and thus can cause sterility.

During the course of investigation of a group of women complaining of sterility, six cases were encountered in whom the semen penetration test[1] was negative. This test consists of putting a drop of semen and cervical mucus upon a slide, so that the surfaces become contiguous when covered by a glass cover slip. The test is positive if columns of spermatozoa can be seen (under the microscope) in the cervical mucus. The test is negative when the spermatozoa are repelled by the mucus so that they cannot penetrate it. At the same time that this test was performed, the hydrogen ion concentration of the cervical mucus was determined. An indicator with a range from a hydrogen ion concentration of 4 to 10 was used. In five of these cases the hydrogen ion concentration was 6 or less during various phases of a menstrual cycle. There was no local condition such as endocervicitis which might possibly account for this abnormality. Attempts to alter this condition by local treatment, injection of estrone or progesterone failed. Repeated attempts at artificial insemination were also unsuccessful. These patients were then given 10 mg. of pregneninolone (pranone) twice a day through the cycle and the effects observed. The case reports follow:

CASE REPORTS

CASE I. G. M., age thirty, married four years, had never been pregnant. General physical and vaginal examinations were negative (except for a slight degree of cervical hypoplasia). Basal metabolism was +10. Endometrial biopsy showed a mixed endometrium with secretory changes. Lipiodol revealed a normal uterus with patent tubes. Weekly vaginal smears ranged from +3 to +4, vaginal hydrogen ion concentration from 4 to 6. Semen penetration was negative. The hydrogen ion concentration of the cervical mucus was 6. Nine attempts at artificial insemination were unsuccessful. Five mg. of proluton given in the second half of the cycle every other day did not alter either the cervical hydrogen ion concentration or the penetration test. This procedure was carried out for three successive months. Ten mg. of pregneninolone (pranone) tablets were given twice a day and after six weeks the hydrogen ion concentration was 8 and penetration test was positive. Three weeks later the patient became pregnant.

CASE II. I. B., age twenty-eight, sterile for four years had a normal menstrual history.

* From the Division of Female Sex Endocrinology, Brooklyn Jewish Hospital.

General examination was negative except for a slight hypoplasia of the cervix. Basal metabolism was −10. Lipiodol revealed a normal uterus and patent tubes. The hydrogen ion concentration of the cervical mucus was 5. Semen penetration test was negative. The patient had received therapy for five months, including biweekly injections of pregnancy urine gonadotropic extract (Antuitrin-S), biweekly injections of 10,000 International Units of an estrogen, subsequently followed by injection of progesterone, previous to her present study. Weekly vaginal smears and vaginal hydrogen ion concentration were normal. Ten mg. pregneninolone (pranone) tablets twice daily were prescribed for her. After seven weeks the semen penetration test was positive and the cervical hydrogen ion concentration was 7. After ten weeks the patient became pregnant.

TABLE I

Patient	Age	Endometrial Biopsy	Cervical Hydrogen Ion Concentration through Cycle	Semen Penetration through Cycle	Pregneninolone (Ethinyl Testosterone) Dose	Results—Cervical Hydrogen Ion Concentration
1. G. M. Para 1.	30	Proliferative with some secretory changes	6	Negative	10 mg. twice a day, 6 weeks	Hydrogen ion concentration 8 after six weeks
			6	"		Semen penetration positive
			5	"		Pregnancy in three weeks
2. I. B. Para 1.	28	None	6	"	10 mg. twice a day, 7 weeks	Hydrogen Ion Concentration 7 after seven weeks
			6	"		Semen penetration positive
			5	"		Pregnancy three weeks later
3. F. S. Para 1.	26	Secretory	6	"	10 mg. twice a day, 7 weeks	Hydrogen Ion concentration 8 in seven weeks
			6	"		Semen penetration positive
			6	"		No pregnancy
4. E. M. Para 11.	30	None	6	"	10 mg. twice a day, 8 weeks	Hydrogen ion concentration 8 in eight weeks
			5	"		Semen penetration positive
			5	"		Pregnancy two weeks later
5. A. H. Para 1.	32	Secretory	5	"	10 mg. twice a day, 10 weeks	Hydrogen ion concentration 5
			5	"		Semen penetration unchanged
			5	"		No pregnancy
6. D. M. Para 1.	25	None	8	"	1. 5 mg. twice a day, for 4 weeks	No change
			8	"	2. 10 mg. twice a day, for 4 weeks	Semen penetration positive in six weeks
			8	"		No pregnancy

CASE III. F. S., age twenty-six, had been sterile six years. Her menses began at fifteen, were irregular for about seventeen months, but then occurred every twenty-eight days until the present time. There was no dysmenorrhea or other menstrual molemina. Hormone study revealed a negative prolan and 9 rat units of estrone. Premenstrual endometrial biopsy revealed secretory changes in the endometrium. Weekly vaginal hydrogen ion concentration ranged from 4 to 5, vaginal smears from −3 to +4. The hydrogen ion concentration of the cervical mucus was 6 and the semen penetration test was negative. Injection of 5 mg. of progesterone every other day in the second half of the cycle (for two successive periods) also did not bring any change. Administration of 10 mg. pregneninolone (pranone) tablets twice a day throughout the cycle brought about a positive semen penetration test and a cervical hydrogen ion concentration of 8 in seven weeks. The patient, however, has still not become pregnant.

CASE IV. E. M., age thirty, has one child five years old but has been unable to become pregnant for the past three years. General

examination was entirely negative. Basal metabolism was +4. Hormone study (premenstrual) revealed a negative prolan and 12 rat units of estrone. Weekly vaginal smears and hydrogen ion concentration were normal. The hydrogen ion concentration of the cervical mucus was 5 to 6. The semen penetration test was negative. The patient was given 10 mg. of pregneninolone (pranone) tablets twice a day and after eight weeks the hydrogen ion concentration was 8. The semen penetration test was positive and the patient became pregnant two weeks later.

Case v. A. H., age thirty-two, had been sterile seven years. In 1933, she had a spontaneous miscarriage at five months followed by a dilatation and curettage. Menses began at sixteen; it occurred every twenty-eight days and lasted six days. The patient's breasts were painful for about one week premenstrually. Basal metabolism was +8. *X*-ray of the uterus revealed bilateral patency of tubes. Premenstrual endometrial biopsy revealed secretory changes in the endometrium. Weekly vaginal hydrogen ion concentrations and smears were normal. The hydrogen ion concentration of the cervical mucus was 5 and the semen penetration test was negative. The patient was given 10 mg. of pregneninolone (pranone) tablets twice a day for ten weeks. However, no change in cervical hydrogen ion concentration of semen penetration test has been observed up to the present time.

Case vi. A twenty-five-year old married woman, complained of secondary sterility. Three years before, immediately after marriage, an abortion had been performed. The physical examination was essentially negative. Menses were regular, monthly, and associated with dysmenorrhea. The basal metabolism was −2. The Rubin test was positive. Vaginal smears showed cornified epithelium. Prolan was negative, estrone was 6 rat units in a twenty-four-hour specimen. She had been treated with corpus luteum and pregnant mare serum every other day for one month with no results. She was first seen on February 9, 1941. The hydrogen ion concentration of the cervix was 8 and a semen penetration test was negative. The semen examined at this time showed a normal morphology and the total quantity was 5 cc. Viscosity was slightly below normal and the total number of spermatozoa was 35,000,000. She was given pregneninolone (pranone), 5 mg. tablets twice daily. Her last menstrual period was on February 2, 1941. On February 21, 1941 another semen penetration test was done. It was still negative although a number of spermatozoa penetrated the cervical secretion. She menstruated again on March 4, 1941. Pregneninolone (pranone) tablets were increased to 20 mg. daily. On March 19, 1941, a semen penetration test was done and this time quite a large number of spermatozoa penetrated the cervical mucus. These spermatozoa, however, shortly lost all motility. The semen examined at this time showed no change from the previous examination. On March 31, 1941, another semen penetration test was done and at this time the test was normal. The patient menstruated again on April 6, 1941.

SUMMARY

1. Pregneninolone (pranone) was given to six patients who had a negative semen penetration test and a hydrogen ion concentration of cervical mucus ranging from 5 to 6; the hydrogen ion concentration in one of the cases, however, was 8.

2. The acidity of the cervical mucus was changed to a hydrogen ion concentration of 7 or 8 and semen penetration test became positive in five cases.

3. Three of these patients subsequently became pregnant.

4. There was no change in one case.

We wish to thank the Schering Corporation for their generous supply of Ethinyl Testosterone (Pranone).

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ADVANTAGES OF EARLY OPERATION IN UNDESCENDED TESTIS

L. M. RANKIN, M.D. AND SHERMAN A. EGER, M.D.
Chief of Service, Delaware County Hospital — Assistant Surgeon, Delaware County Hospital
UPPER DARBY, PENNSYLVANIA

IT is definitely known that the longer a testicle remains undescended, that is outside of its normal position in the scrotum, the greater are the possibilities of permanent impairment of its physiological functions. Furthermore, an undescended testicle is more liable to torsion, trauma, inflammation and malignancy.

With the knowledge of these dangers and with the introduction of hormonal therapy and improved surgical technic, the practice of waiting for spontaneous descent of undescended testicles at puberty is rapidly being discontinued. One would expect a deficiency in hormones to be more of a causative factor in bilateral undescended testicles than in unilateral cases and that the latter would be less responsive to hormonal therapy. This was proved by Einhorn and Rowntree[1] who in a study of forty cases of cryptorchidism treated by hormones, found that complete descent occurred in 43 per cent of bilateral and only 23 per cent of unilateral cases. It is, therefore, evident that the failure of the descent of the testis is due to mechanical factors in the majority of cases and especially in the unilateral ones. Furthermore, Mimpriss[2] found a co-existing hernia in 85 per cent of 137 patients operated upon. Strauss[3] in a series of thirty-eight cases found hernias in 82 per cent and stated that in these the descent of the testicle or cure by injection therapy could not be expected.

In the past three years we have operated on seven patients with undescended testes at the Delaware County Hospital in Drexel Hill using the two-stage method described by Torek[4] and known as the Torek operation. Five of these cases have been completed surgically and are herewith reported. Two more recent cases have only had the first stage completed and will not be included. Although this series is comparatively small, it has presented certain factors worthy of note.

CASE REPORTS

CASE I. J. B., age five, had his left testicle in the normal position in the scrotum. At operation the right testicle was high in the inguinal canal near the internal ring, slightly smaller than normal and was accompanied by a hernia. Sufficient cord length was obtained to permit anchoring of testicle to the thigh without tension; the hernia was repaired. The second-stage operation was performed four months later. After three years the right testicle was the same size as the left, it was freely movable and in the normal position in the scrotum.

CASE II. M. B., age twelve. The right testicle had always been normal in the scrotum. During two years of hormonal therapy, starting at age ten, the left testicle descended from the midinguinal region into the perineum lateral to the scrotum. At operation the left testicle was slightly smaller than the right and was accompanied by a hernia. Sufficient cord length was obtained to permit anchoring testicle to the thigh without tension and the hernia was repaired. The second-stage operation was done four months later. After three years the left testicle was one-third smaller than the right, it was freely movable and in the normal position in the scrotum.

CASE III. J. B. age thirteen. The patient's left testicle had always been normal in the scrotum. Hormonal therapy had been carried out for two years, starting at the age of eleven for tender, undescended right testicle without benefit. At operation the right testicle was definitely smaller than the left in the midinguinal canal and was accompanied by a hernia. The shortened vas necessitated higher anchorage of the testicle to the thigh than desirable. The hernia was repaired. The second-

stage operation was performed four months later. After three years the right testicle was one-half the size of the left, freely movable, but higher in the scrotum.

Case IV. J. B., age thirteen. The patient's right testicle had always been normal in the scrotum. No hormone therapy had been used. At the age of three it was discovered that the left testicle was undescended. The physician advised the parents to wait until puberty for operation. At operation the left testicle was smaller than the right and was in the midinguinal canal, accompanied by a hernia. The shortened vas necessitated higher anchorage of the testicle to the thigh than desirable and the hernia was repaired. A second-stage operation was done five months later. After six months the left testicle was one-half the size of the right and freely movable in the midscrotal position.

Case V. R. U., age ten. A right undescended testicle was discovered at the age of two and the physician advised waiting until the age of ten for operation. No hormonal therapy was carried out. The left testicle was normal in size and was located high in the scrotum and would retract to the midinguinal canal. At operation the right testicle was very small in the midinguinal canal and was accompanied by a hernia. The shortened vas necessitated higher anchorage of the testicle to the thigh than desirable and the hernia was repaired. The left testicle was normal size in the inguinal canal near the external ring and was accompanied by a hernia. Sufficient cord length was obtained for anchorage of the testicle to the thigh without tension and the hernia was repaired. A second-stage operation was performed four months later. After six months the right testicle was still very small, freely movable and in the midscrotal position. The left testicle was normal in size, freely movable and normal in the scrotum.

SUMMARY

1. Case I, II and III were brothers.

2. The best result was obtained in Case I in which the undescended testicle was found to be normal in size at operation and the vas not shortened.

3. Less satisfactory results were obtained in the remaining four patients, ranging in age from ten to thirteen years, in all of which the undescended testicles were found to be smaller than normal at operation and have not increased in size since.

4. In the older patients the vas was relatively short, preventing the testicle from being placed in an ideal position in the scrotum.

5. A hernia accompanied each undescended testicle in this series.

CONCLUSIONS

The high percentage of mechanical factors causing incomplete descent of the testicle, as well as the high incidence of associated hernia, makes operation the treatment of choice in the vast majority of cases. We believe that the best age for operation is around five years, because by that time the child is properly trained in toilet habits, thus minimizing the chances of contaminating the operative wounds; after that age the degree of testicular atrophy and relative shortening of the vas increases, thereby influencing, proportionately, the physiological and anatomical results.

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New Instruments

A NEW INSTRUMENT FOR FACILITATING THE ADMINISTRATION OF INTRAVENOUS FLUID

LOWELL L. EDDY, M.D.
Surgical Resident, Virginia Mason Hospital
SEATTLE, WASHINGTON

ONE of the technical problems encountered in administering intravenous fluids at the antecubital fossa, the usual infusion site, is that the patient's arm and forearm commonly must be immobilized at the elbow during the procedure. The associated pain and resulting stiffness are a source of considerable discomfort, which this new instrument practically eliminates. Infusions in the forearm and wrist do not require immobilization of the elbow but in many patients the antecubital veins are better suited anatomically for intravenous procedures.

We are presenting an instrument that fixes the intravenous needle in a vein at the antecubital fossa and still allows moderate freedom of motion at this joint during an infusion. Many "needle-holders" have been devised to immobilize a needle in a vein, i.e., to prevent anterioposterior and lateral motion. To our knowledge there has been no device described that has the characteristic features of the instrument here presented. (Fig. 1.)

During a clinical trial with more than 1,000 infusions using this intravenous clamp at The Brooklyn Hospital and The Lenox Hill Hospital in New York and The Virginia Mason Hospital in Seattle it has been found unnecessary to immobilize the upper extremity even during prolonged intravenous procedures.

If the patient flexes his arm more than ninety degrees, the proximal end of the clamp will press against the upper arm, breaking any further upward movement.

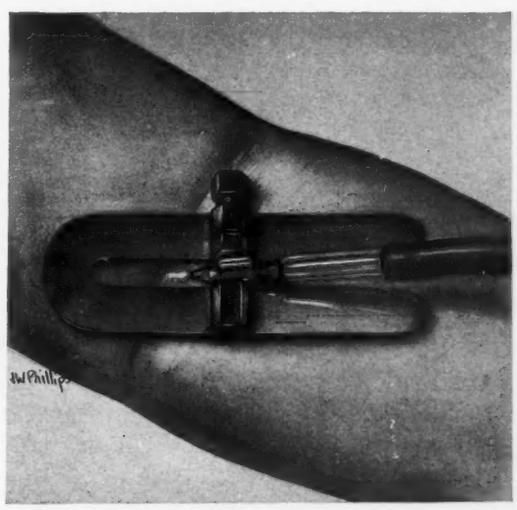

FIG. 1. Sketch of the intravenous clamp in position. Note oblique direction of the needle.

But the flow of the infusion is not obstructed, for when the elbow is flexed the proximal end of the clamp rolls the mobile soft tissues and the vein with its needle medialward in an oblique direction rather than compressing the vein wall.

The actual application of the intravenous clamp to a needle with a rectangular hub is illustrated in the accompanying pictures. Insert the needle to its hub after entering the skin about one inch distal to the flexion crease at the elbow. Advance the open end of the U-shaped clamp from above downward along the skin over the shaft of the

needle until the vise portion of the clamp is at the needle hub. (Fig. 2.)

Tilt the glass connecting tube to a ten degree angle above the metal base of the clamp; then tighten the screw to the vise. Next, strap each end of the clamp firmly to the arm with adhesive tape, the upper strap above the bend of the elbow, holding the instrument over the antecubital fossa as in Figure 3.

FIG. 2. Method of applying the instrument. Advance the intravenous clamp from above downward to the needle hub.

FIG. 3. Final position of the instrument. Note the placement of the adhesive tape.

FIG. 4. An illustration of a patient reading a paper during an infusion.

The open slit of the U-shaped clamp should overlie the oblique course of the vein. With the instrument in this position about ninety degrees of motion of the elbow joint is permitted. (Fig. 4.)

SUMMARY

A new instrument called an intravenous clamp is presented. It is a needle holder with the characteristic feature that it fixes a needle in one of the veins at the antecubital fossa and still allows moderately free motion of the elbow joint during an infusion, thus eliminating the use of the arm board. Its value is best demonstrated during prolonged intravenous procedures and with nonco-operative patients who resist restraint.

The use of this instrument to facilitate the administration of plasma to the war wounded enroute from battle field to hospital is suggested.

I acknowledge with appreciation the efforts of Mr. Waldemeyer Ayers for his part in the design and creation of this instrument.

A COMMON DUCT FORCEPS AND A FLEXIBLE CANNULA*

R. Russell Best, M.D.
OMAHA, NEBRASKA

DURING the last ten years, opening and exploring the common duct has become a more and more frequent accompaniment of cholecystectomy. In my own series, it has been carried out in about 30 per cent of the cases. A thorough exploration of the common duct requires palpation for stones, and visualization for thickening or dilatation of the duct, followed by internal exploration by means of forceps, scoops, irrigations and suction. Many times one is handicapped in getting into the common duct with the duct forceps most frequently used. This is particularly true in the obese individual, in cases in which the common duct is very deep within the abdomen, or when the surface of the common duct, which can be exposed between the upper margin of the duodenum and undersurface of the liver, is very short.

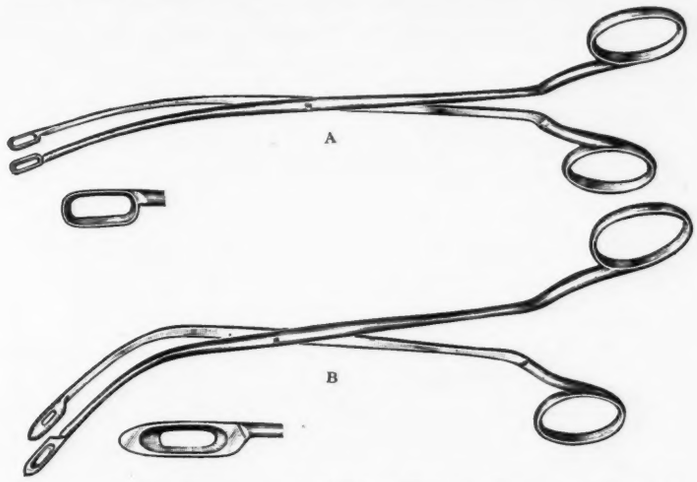

FIG. 1. A, shows instrument with insufficient curve. B, shows the recently designed instrument with the end which serves as a dilator.

FIG. 2. A flexible silver cannula with beaded area for dilatation of sphincter area. A Luer syringe may be attached to the other end for irrigating purposes.

The usual common duct stone forceps has the angle shown in Figure 1 A. There is a modification of this instrument with a slight, but not sufficient, increase in the curve and with only a very short curved portion so that one cannot get far down

* From the Department of Surgery, University of Nebraska College of Medicine.

into the common duct. Figure 1 B depicts a recently designed instrument that I have been using in which the degree of curve is greater, and in working at a depth one has no difficulty in maneuvering the instrument into the common duct. Also because the instrument is longer beyond the lock, one can easily reach the lower confines of the common duct. The head of this common duct stone forceps is shaped so as not only to be able to grasp stones but the bulbous tip also permits the instrument to pass through the sphincter area and act as a dilator. I do not believe it is necessary to open the forceps and dilate the sphincter area further.

Exploration of the common duct is not complete until the duct has been irrigated with sterile normal saline and certainly one is not sure that the lower end of the duct is freely open until it has been definitely established that fluid can be irrigated directly into the duodenum. With a rubber catheter this has always seemed a rather awkward and cumbersome procedure, sometimes consuming considerable time. The flexible silver cannula shown in Figure 2, which is rather similar to a Mixter cannula, may be angulated so as to be easily inserted into the common duct and directly through the sphincter area without difficulty, if no obstructing agent is present. The end is blunt and beaded and the larger olive-shaped area just behind this enables one to use the instrument as a small caliber dilator and probe. At the proximal end there is a hub for attachment of a Luer syringe.

In rare instances, there occurs an extreme type of sinus arrhythmia in which there is sufficient inhibition of the node to cause the heart to pause for an abnormally long period (cardiac standstill). In severe cases symptoms similar to the Adams-Stokes syndrome in heart block occur.

AN ADJUSTABLE STAND FOR ELEVATING THE EXTREMITIES

D. N. Di Silvio, M.D.
PITTSBURGH, PENNSYLVANIA

ALL wounds of the extremities, whether clean or infected, require rest and an adequate circulation for proper healing. In extensive trauma or infection, the accompanying edema interferes markedly with the local circulation. The proper application of moist heat in the form of fomentations of various types contributes a great deal toward maintaining proper circulation. The simple expedient of elevating infected extremities is of inestimable value. Venous and lymphatic stasis disappear rapidly. The common procedure is to elevate the affected member on pillows. This, however, merely keeps the diseased area on the same level as the rest of the extremity. It does not permit satisfactory drainage of the congested area. It is essential that the involved part be on a higher level than the part proximal to it. Wooden triangles placed on the bed or night table are cumbersome. Difficulty is encountered in effectively maintaining elevation of the arm since, as the patient moves about in bed, the position of the arm shifts. This frequently causes angulation at the elbow joint with resulting angulation of the blood vessels.

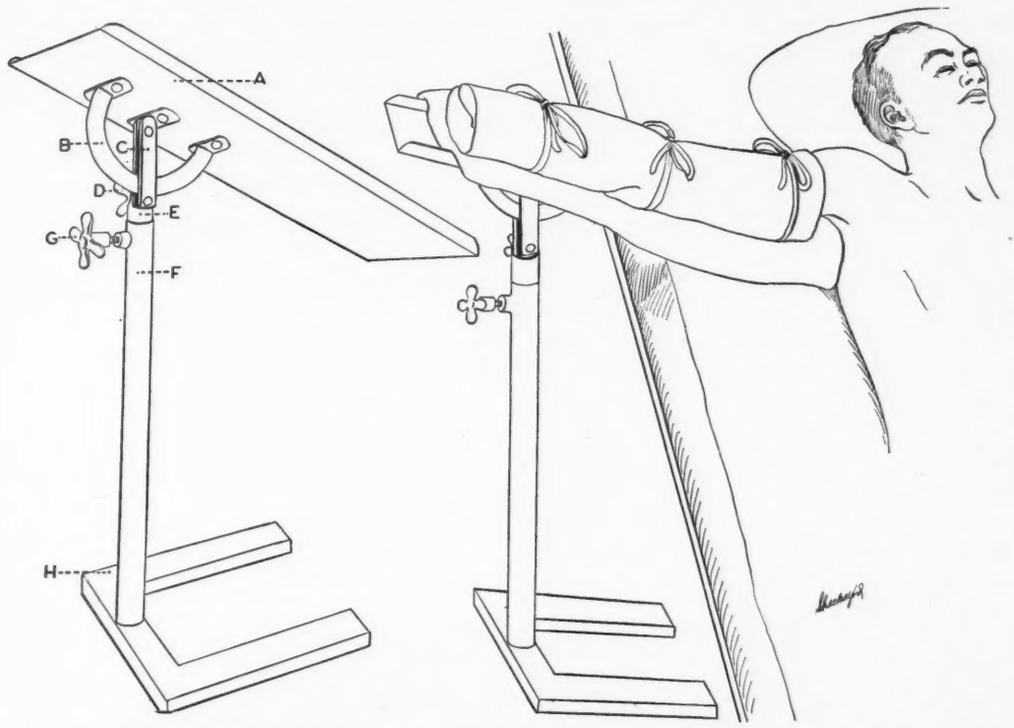

FIG. 1. Drawing of adjustable stand. A, aluminum arm rest; B, semicircular bar; C, clamp supporting arm rest and fixed to inner tubing; D, knob controlling semicircular bar, B, and ∴ degree of elevation; E, inner tubing; F, outer tubing; G, knob controlling height of stand; H, base.

This simple stand was devised so as to facilitate the thorough carrying out of elevation of the extremities. The Gatch bed obviates its use for elevating the lower extremities. The stand is constructed of one and one-half inch tubing F which is

welded on to rectangular steel tubing to form a stable base H. Tubing E one and one-fourth inches in diameter fits into the former, thus permitting the stand to be raised or lowered at will. The desired height is fixed by knob G. An aluminum arm rest A can be tilted at the desired angle by permitting a semicircular bar B to rotate through clamp C. The arm rest is fastened to the clamp which in turn is fixed to the inner tubing E. This degree of elevation is controlled by knob D. The extremity, therefore, can be abducted or adducted and raised or lowered to the desired degree.

ATROPHY of part or all of *both* extremities results from multiple neuritis, anterior poliomyelitis, the Charcot-Marie-Tooth type of atrophy, progressive muscular atrophy, Friedreich's ataxia, transverse myelitis and bilateral bone or joint disease.

The brief excerpts in this issue have been taken from "Physical Diagnosis" by Cabot and Adams (The Williams & Wilkins Company.)

THE USE OF CURVED SPIRIT LEVELS IN ORTHOPEDICS

TOUFICK NICOLA, M.D.
Clinical Professor of Orthopedic Surgery, New York Polyclinic Hospital Post-Graduate Medical School
MONTCLAIR, NEW JERSEY

THE author has found two curved spirit levels useful in certain orthopedic procedures. The larger curved spirit level (Fig. 1) has a diameter of six inches and is attached to a rubber strap two inches wide and eighteen inches long. The smaller curved spirit level (Fig. 2) has a diameter of four inches and is attached to an aluminum base. Both levels have ten degree markings.

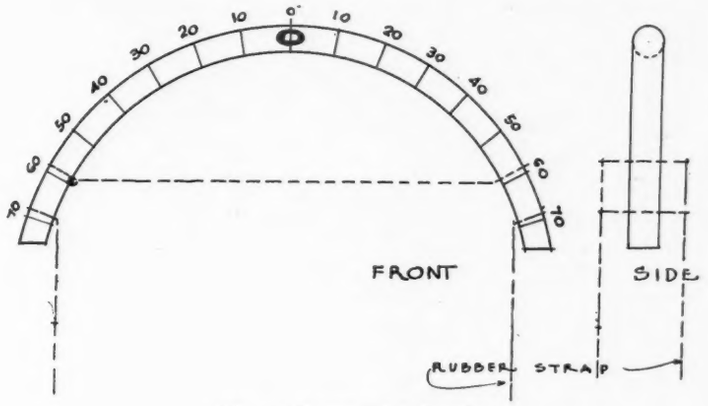

FIG. 1. Large spirit level.

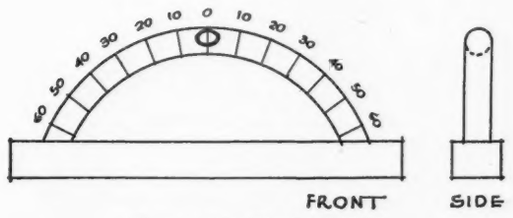

FIG. 2. Small spirit level.

These curved spirit levels have been found useful:

1. *To measure degrees of rotation in the hip joint.* To do this the large curved spirit level is strapped to the lower thigh just above the knee with the zero mark in line with the center of the patella (marked with a skin pencil). When the limb is rolled in, then out, the degrees of internal and external rotation are read where the bubble comes to a standstill. (Fig. 3.)

2. *To measure the degree of torsion of the tibia.* Two curved spirit levels are used in this determination. The larger one is strapped to the lower thigh as described above. The smaller one is placed on the plane connecting the tips of the internal and external malleoli. The difference in the readings between the two curved spirit levels gives the degree of torsion of the tibia. (Fig. 4.)

3. *To direct the Smith-Petersen nail, wire or screw in extra-articular treatment of fractured hips.* A lateral *x*-ray is taken (Dooley) and from this *x*-ray the angle of torsion, between the axis of the neck of the femur and the bicondylar axis (angle of inclination), is determined. If this is twenty

degrees and if, after reduction, the thigh is rolled in twenty degrees, then the smaller spirit level (placed on the driver which directs the nail, wire or screw) should read zero. The degree of internal rotation of the hip is read on the larger curved spirit level which is placed just above the patella. If the limb is rolled in thirty degrees in cases in which the angle of inclination is found to be twenty degrees, the smaller curved spirit level should read ten degrees. (Fig. 5.)

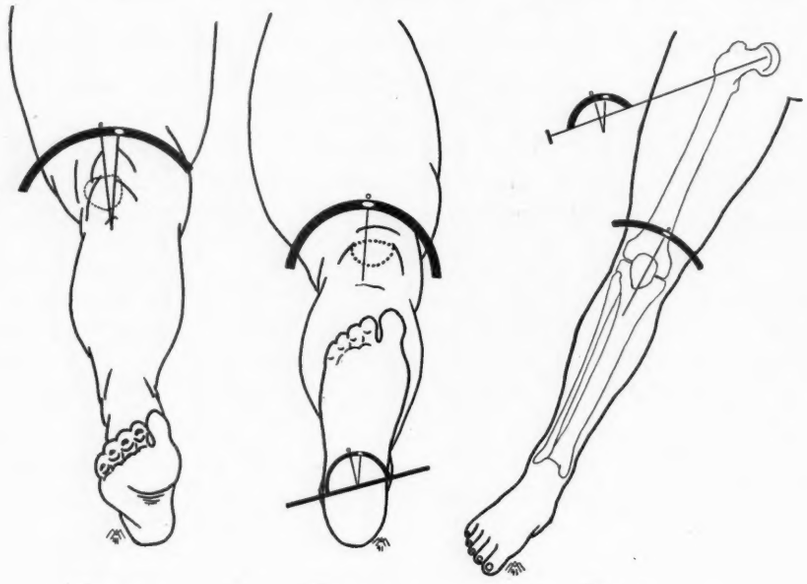

Fig. 3. Fig. 4. Fig. 5.

Fig. 3. Measuring degree of rotation at hip.
Fig. 4. Measuring torsion of tibia.
Fig. 5. Measuring direction of Smith-Petersen nail, wire or screw.

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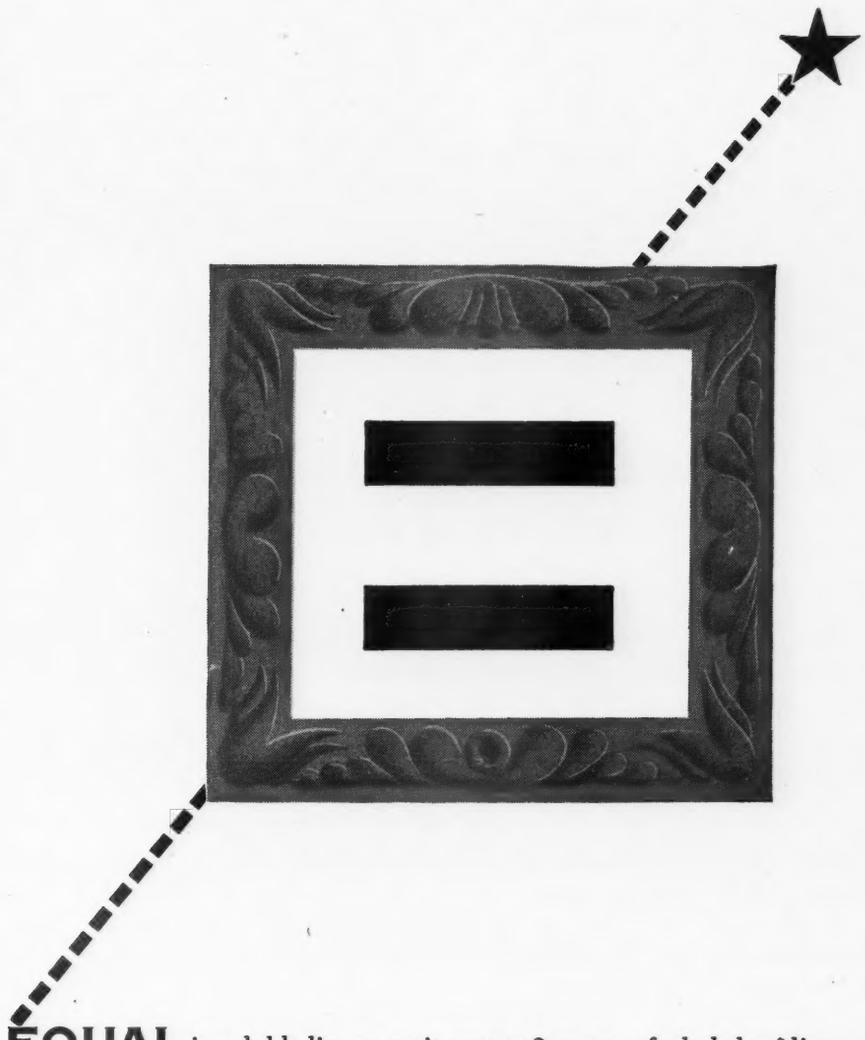

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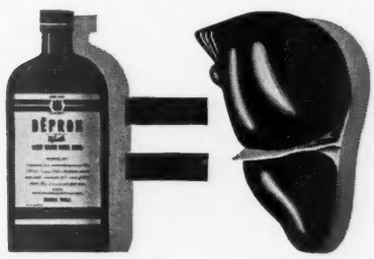

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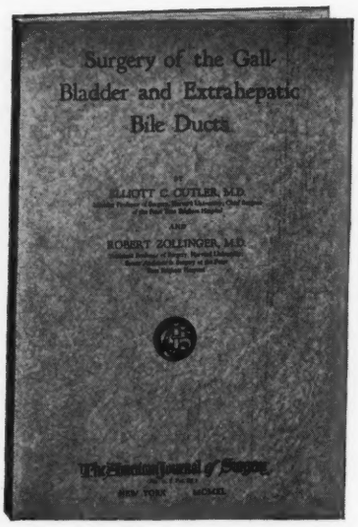

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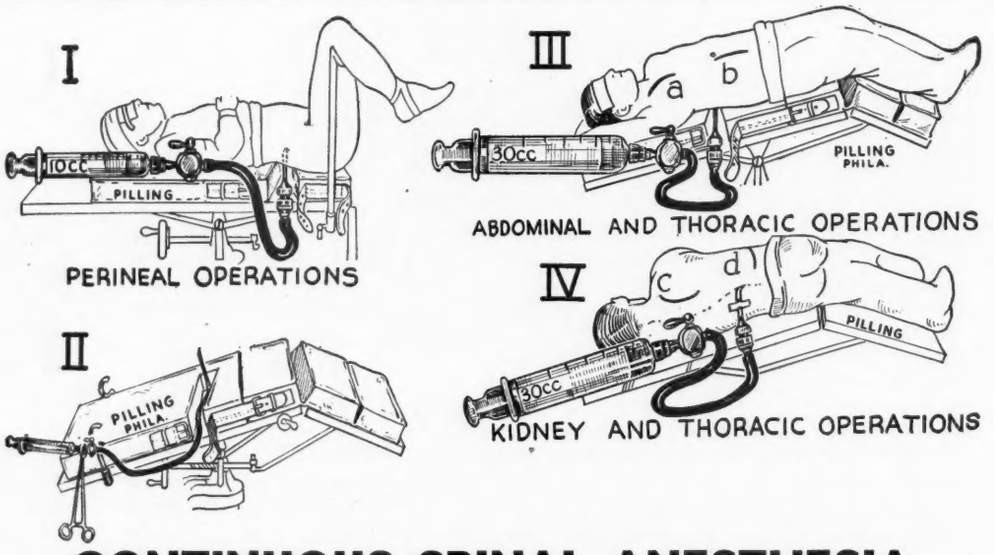

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Atlanta, June 1–3, 1942. (Secretary—DR. T. C. DAVISON, 478 Peachtree St., N.E., Atlanta, Ga.)

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Cincinnati, April 13–17, 1942. (Secretary—MR. ARMOUR G. PARK, 540 N. Michigan Ave., Chicago)

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Chicago, September 10–12, 1942. (Secretary—DR. R. B. KEPNER, 547 W. Jackson Blvd., Chicago)

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AMERICAN CONGRESS OF PHYSICAL THERAPY

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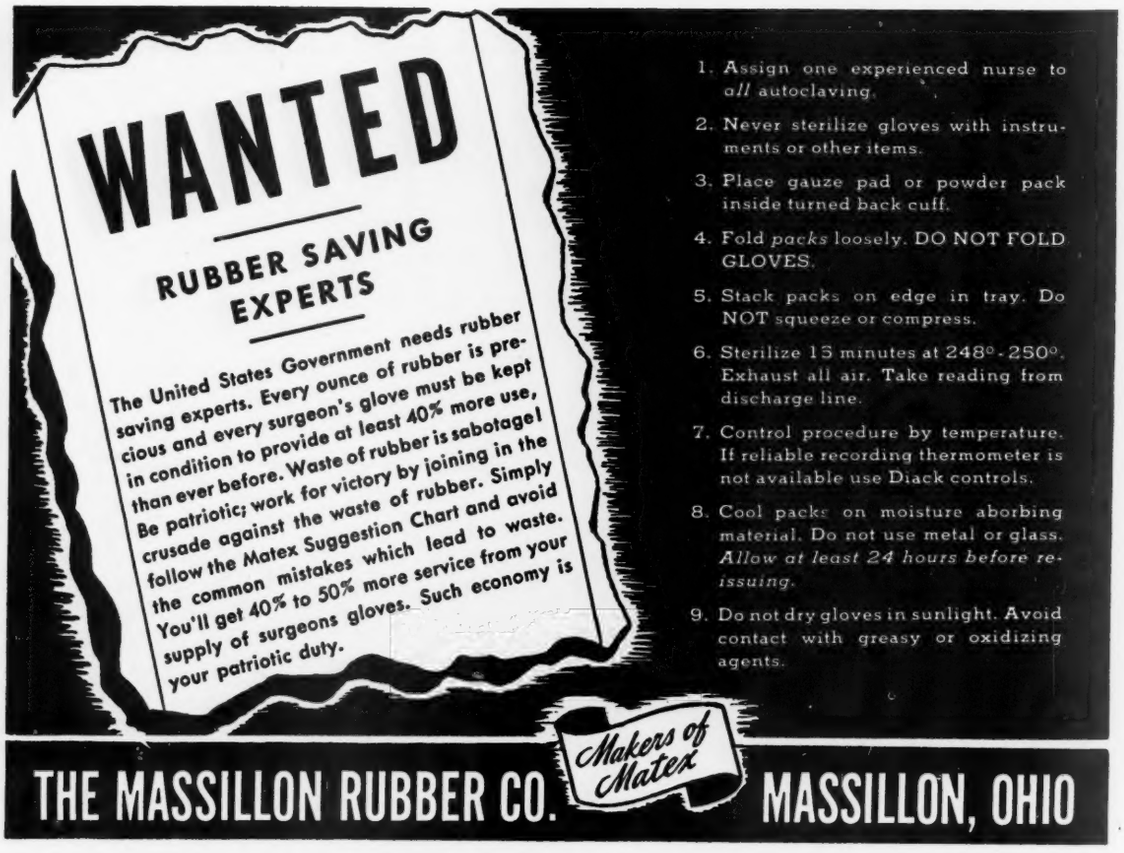
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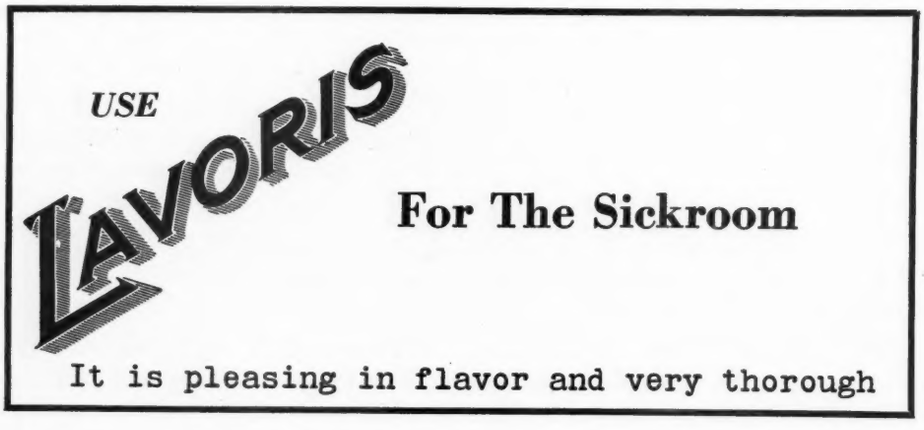
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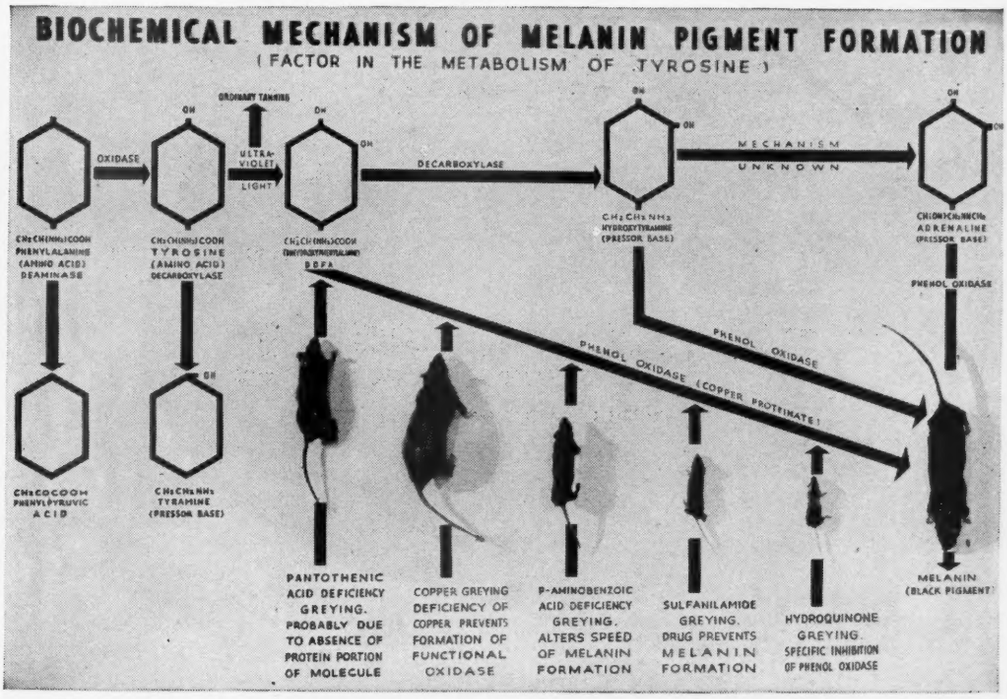
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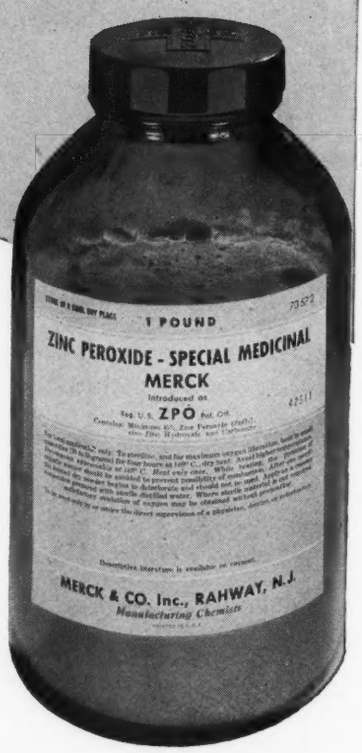

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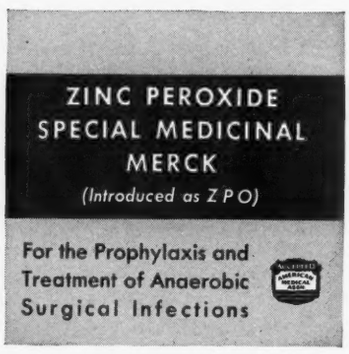

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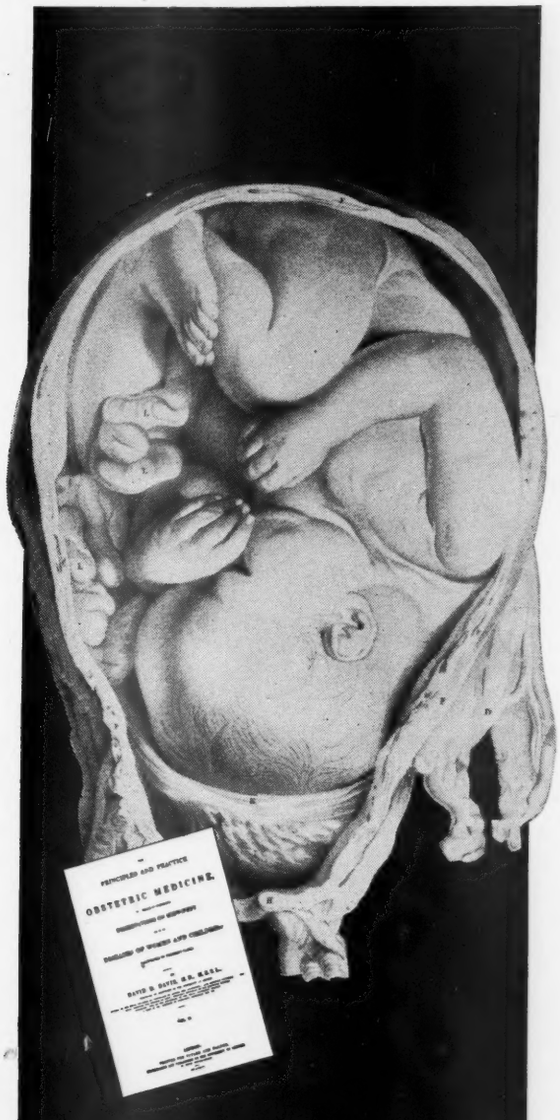

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The American Journal of Surgery

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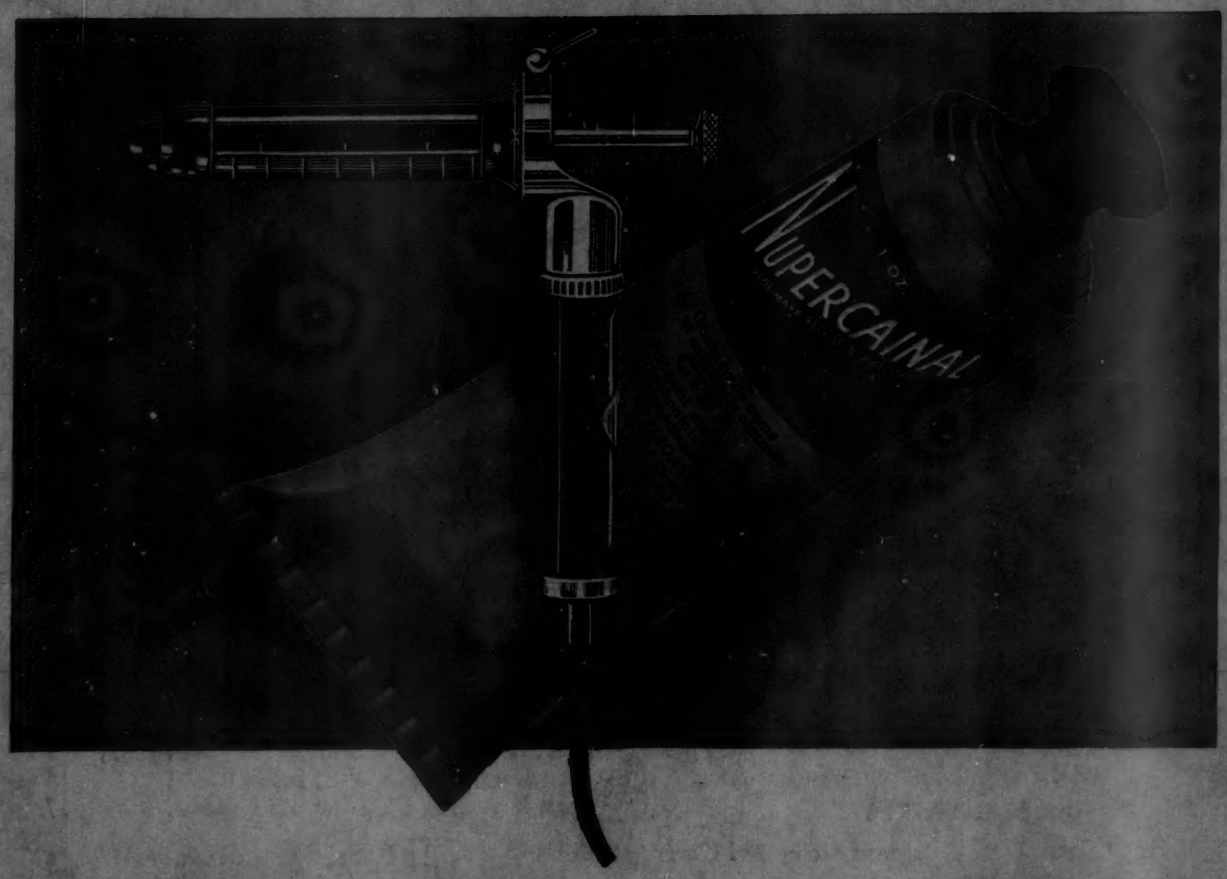

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